

# Supporting Information

## Synthesis of Isocoumarins with Different Substituted Patterns via Passerini-Aldol Sequence

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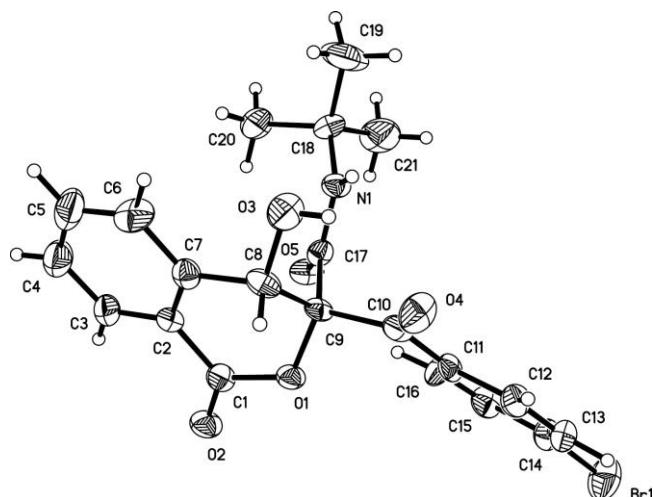
## Table of Contents

General information-----	S1
X-ray Crystallography Structure of Compounds <b>4a</b> and <b>5a</b> -----	S2
General Procedure for the Synthesis of Compounds <b>4a</b> and <b>5i</b> -----	S2
Characterization Data of Compounds <b>4a-4q</b> -----	S4-S10
Characterization Data of Compounds <b>5a-5k</b> -----	S11-S15
Copies of <sup>1</sup> H and <sup>13</sup> C NMR Spectra for Compounds <b>4a-4q</b> -----	S16-S32
Copies of <sup>1</sup> H and <sup>13</sup> C NMR Spectra for Compounds <b>5a-5k</b> -----	S33-S43

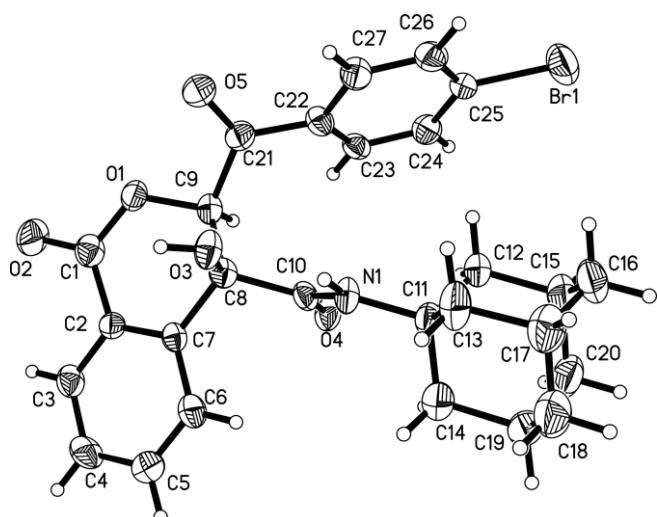
## Experimental

### General Information

Microwave irradiation was carried out with Initiator 2.5 Microwave Synthesizers from Biotage, Uppsala, Sweden. IR spectra were taken on a FT-IR-Tensor 27 spectrometer in KBr pellets and reported in  $\text{cm}^{-1}$ .  $^1\text{H}$  NMR ( $^{13}\text{C}$  NMR) spectra were measured on a Bruker DPX 400 MHz spectrometer in  $\text{DMSO}-d_6$  with chemical shift ( $\delta$ ) given in ppm relative to TMS as internal standard [(s = singlet, d = doublet, t = triplet, brs = broad singlet, m = multiplet), coupling constant (Hz)]. HRMS (ESI-TOF) was determined by using microTOF-Q II HRMS/MS instrument (BRUKER). X-Ray crystallographic analysis was performed with a Siemens SMART CCD and a Siemens P4 diffractometer.



**Fig 1,** X-ray Structure of **4a**



**Fig 2,** X-ray Structure of **5i**

## **General Procedure for the Synthesis of 4**

Example for the synthesis of **4a**: *N*-(*t*-Butyl)-3-(4-bromobenzoyl)-4-hydroxy-1-oxoisochroman-3-carboxamide

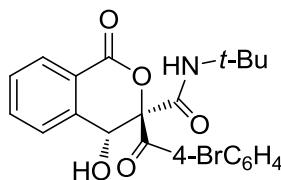
Typically, 2-carboxybenzaldehyde (150 mg, 1.0 mmol) was introduced in a 25-ml reaction vial, *tert*-butyl isonitrile (83 mg, 1.0 mmol), and 4-bromophenylglyoxal monohydrate (230 mg, 1.0 mmol), as well as 1,4-dioxane (1.5 ml), were then successively added into this reaction mixture. The reaction system was stirred at room temperature for overnight. After the completion of the reaction (monitored by TLC), solvent was removed under vacuum. The residue was purified by flash column chromatography (silica gel, mixtures of petroleum ether / ethyl acetate) to afford the pure product **4a**.

## **General procedure for the synthesis of 5**

Example for the synthesis of **5a**: 3-(4-Bromobenzoyl)-*N*-(*tert*-butyl)-4-hydroxy-1-oxoisochroman-4-carboxamide

Typically, 2-carboxybenzaldehyde ((150 mg, 1 mmol) was introduced in a 25-ml reaction vial, *tert*-butyl isonitrile (83 mg, 1.0 mmol) and 4-bromophenylglyoxal monohydrate (230 mg, 1.0 mmol) as well as methanol (1.5 ml) were then successively added into this reaction mixture. The reaction system was stirred at room temperature for overnight. After the completion of the reaction (monitored by TLC), solvent was removed under vacuum. The residue was purified by flash column chromatography (silica gel, mixtures of petroleum ether / ethyl acetate) to afford the pure product **5a**.

**N-(*t*-Butyl)-3-(4-bromobenzoyl)-4-hydroxy-1-oxoisochroman-3-carboxamide (4a)**



White solid, mp: 177–179 °C.

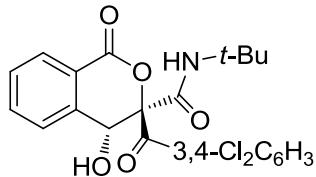
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3367, 2973, 1753, 1680, 1550, 1372, 1233, 1072, 1026, 918, 619.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.02–7.99 (m, 1H, ArH), 7.97–7.92 (m, 2H, ArH), 7.68–7.64 (m, 1H, ArH), 7.60–7.56 (m, 3H, ArH), 7.48 (m, 1H, ArH), 6.95–6.82 (m, 1H, NH), 5.83–5.77 (m, 1H, CH), 3.92 (s, 1H, OH), 1.29 (s, 9H, CH<sub>3</sub>).

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 191.7, 164.1, 161.7, 138.3, 135.0, 132.3, 132.0, 131.4, 130.2, 129.8, 129.6, 127.3, 122.8, 90.1, 68.0, 52.6, 28.4.

HRMS (ESI)  $m/z$ : calcd for C<sub>21</sub>H<sub>19</sub>BrNO<sub>5</sub>: 444.0447 [M-H]<sup>-</sup>; found: 444.0458.

**N-(*t*-Butyl)-3-(3,4-dichlorobenzoyl)-4-hydroxy-1-oxoisochroman-3-carboxamide (4b)**



White solid, mp: 186–187 °C.

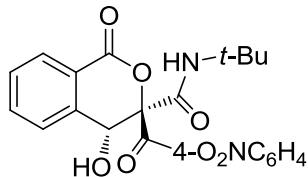
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3383, 2973, 1752, 1681, 1549, 1458, 1371, 1271, 1229, 1072, 918, 741;

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.07–7.98 (m, 2H, ArH), 7.85 (d,  $J$  = 8.4 Hz, 1H, ArH), 7.72–7.61 (m, 2H, ArH), 7.50 (m, 2H, ArH), 6.47 (s, 1H, NH), 5.48 (d,  $J$  = 5.6 Hz, 1H, CH), 3.75 (d,  $J$  = 6.3 Hz, 1H, OH), 1.31 (s, 9H, CH<sub>3</sub>);

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 190.3, 164.0, 161.5, 139.0, 138.3, 135.2, 133.4, 132.9, 131.7, 130.8, 130.3, 129.7, 129.0, 127.4, 122.6, 89.9, 67.8, 52.7, 28.4;

HRMS (ESI)  $m/z$ : calcd for C<sub>21</sub>H<sub>18</sub>Cl<sub>2</sub>NO<sub>5</sub>: 434.0562 [M-H]<sup>-</sup>; found: 434.0533.

**N-(*t*-Butyl)-4-hydroxy-3-(4-nitrobenzoyl)-1-oxoisochroman-3-carboxamide (4c)**



White solid, mp: 192–194 °C.

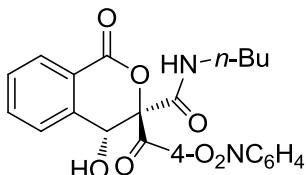
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3319, 2971, 1753, 1717, 1526, 1350, 1278, 1230, 1126, 1076, 867, 701.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.25 (m, 4H, ArH), 8.02 (d, *J* = 7.8 Hz, 1H, ArH), 7.69 (d, *J* = 7.4 Hz, 1H, ArH), 7.60 (d, *J* = 7.4 Hz, 1H, ArH), 7.52 (d, *J* = 7.5 Hz, 1H, ArH), 6.90 (s, 1H, NH), 5.77 (s, 1H, CH), 3.54 (s, 1H, OH), 1.31 (s, 9H, CH<sub>3</sub>).

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 195.0, 163.7, 161.5, 150.3, 140.1, 138.1, 135.2, 130.4, 130.2, 129.6, 126.1, 123.5, 122.6, 90.1, 70.3, 52.8, 28.4;

HRMS (ESI) *m/z*: calcd for C<sub>21</sub>H<sub>19</sub>N<sub>2</sub>O<sub>7</sub>: 411.1139 [M-H]<sup>-</sup>; found: 411.1145.

#### ***N*-Butyl-4-hydroxy-3-(4-nitrobenzoyl)-1-oxoisochroman-3-carboxamide (4d)**



White solid, mp: 161-163 °C.

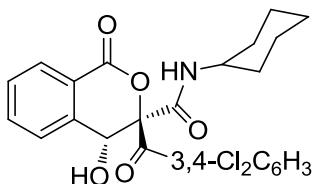
IR (KBr, *v*, cm<sup>-1</sup>): 3317, 2956, 2870, 1727, 1603, 1527, 1348, 1228, 1090, 834, 698.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.26 (d, *J* = 9.0 Hz, 2H, ArH), 8.06 (m, 3H, ArH), 7.71 (t, *J* = 7.6 Hz, 1H, ArH), 7.61 (d, *J* = 7.6 Hz, 1H, ArH), 7.52 (t, *J* = 7.2 Hz, 1H, ArH), 6.77 (t, *J* = 5.6 Hz, 1H, NH), 5.59 (s, 1H, CH), 3.70 (s, 1H, OH), 3.31–3.18 (m, 2H, CH<sub>2</sub>), 1.47–1.37 (m, 2H, CH<sub>2</sub>), 1.20 (m, 2H, CH<sub>2</sub>), 0.84 (t, *J* = 7.2 Hz, 3H, CH<sub>3</sub>);

<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 194.8, 164.4, 161.6, 150.3, 140.0, 137.9, 135.3, 130.6, 130.3, 129.8, 126.6, 123.5, 122.6, 90.6, 70.0, 39.9, 31.1, 19.8, 13.6;

HRMS (ESI) *m/z*: calcd for C<sub>21</sub>H<sub>19</sub>N<sub>2</sub>O<sub>7</sub>: 411.1193 [M-H]<sup>-</sup>; found: 411.1190.

#### ***N*-Cyclohexyl-3-(3,4-dichlorobenzoyl)-4-hydroxy-1-oxoisochroman-3-carboxamide (4e)**



White solid, mp: 178-180 °C.

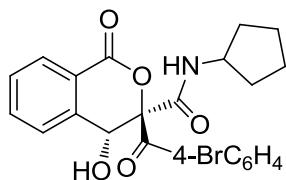
IR (KBr, *v*, cm<sup>-1</sup>): 3352, 2934, 2854, 1717, 1667, 1520, 1287, 1230, 1091, 835, 766.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.02 (t, *J* = 4.8 Hz, 2H, ArH), 7.86 (m, 1H, ArH), 7.70 (t, *J* = 7.6 Hz, 1H, ArH), 7.64 (d, *J* = 7.6 Hz, 1H, ArH), 7.53–7.47 (m, 2H, ArH), 6.59 (d, *J* = 8.4 Hz, 1H, NH), 5.50 (d, *J* = 6.4 Hz, 1H, CH), 3.79–3.67 (m, 2H, CH and OH), 1.80–1.58 (m, 5H, CH<sub>2</sub>), 1.33–1.24 (m, 2H, CH<sub>2</sub>), 1.21–1.09 (m, 3H, CH<sub>2</sub>).

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 193.1, 163.7, 161.6, 138.9, 138.8, 135.3, 134.0, 133.3, 131.5, 130.7, 130.2, 129.5, 128.9, 126.2, 122.4, 89.6, 70.2, 49.2, 32.5, 25.2, 24.6;

HRMS (ESI) *m/z*: calcd for C<sub>23</sub>H<sub>20</sub>Cl<sub>2</sub>NO<sub>5</sub>: 434.0562 [M-H]<sup>-</sup>; found: 434.0533.

**N-Cyclopentyl-3-(4-bromobenzoyl)-4-hydroxy-1-oxoisochroman-3-carboxamide (4f)**



White solid, mp: 158–160 °C.

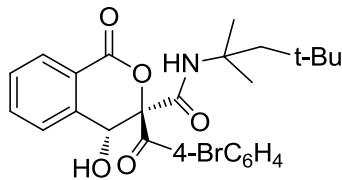
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3362, 2957, 1726, 1690, 1516, 1260, 1116, 1076, 1010, 826, 769.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.01 (d,  $J$  = 7.6 Hz, 1H, ArH), 7.85 (d,  $J$  = 8.6 Hz, 2H, ArH), 7.72–7.56 (m, 4H, ArH), 7.49 (t,  $J$  = 7.6 Hz, 1H, ArH), 6.59 (s, 1H, NH), 5.49 (s, 1H, CH), 3.75–3.69 (m, 2H, CH and OH), 1.96 – 1.88 (m, 2H, CH<sub>2</sub>), 1.66–1.56 (m, 4H, CH<sub>2</sub>), 1.38–1.29 (m, 2H, CH<sub>2</sub>);

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 194.6, 171.2, 164.3, 138.8, 135.1, 133.4, 131.9, 131.3, 130.1, 129.6, 129.5, 126.3, 122.7, 70.3, 52.0, 32.7, 32.7, 23.7, 23.6;

HRMS (ESI)  $m/z$ : calcd for C<sub>22</sub>H<sub>19</sub>BrNO<sub>5</sub>: 456.0447 [M-H]<sup>-</sup>; found: 456.0448.

**3-(4-Bromobenzoyl)-4-hydroxy-1-oxo-N-(2,4,4-trimethylpentan-2-yl)isochroman-3-carboxamide (4g)**



White solid, mp: 175–177 °C.

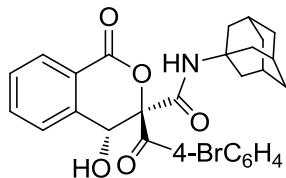
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3367, 2951, 1716, 1671, 1580, 1521, 1366, 1230, 1074, 838, 765.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.06–8.01 (m, 1H, ArH), 7.92–7.84 (m, 2H, ArH), 7.67 (t,  $J$  = 7.6 Hz, 1H, ArH), 7.59 (d,  $J$  = 8.4 Hz, 3H, ArH), 7.48 (t,  $J$  = 7.6 Hz, 1H, ArH), 6.43 (s, 1H, NH), 5.48 (s, 1H, CH), 3.71 (s, 1H, OH), 1.73 (d,  $J$  = 15.0 Hz, 1H, CH<sub>2</sub>), 1.53 (d,  $J$  = 15.0 Hz, 1H, CH<sub>2</sub>), 1.29 (s, 6H, CH<sub>3</sub>), 0.91 (s, 9H, CH<sub>3</sub>);

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 195.1, 163.0, 162.0, 138.2, 134.9, 133.6, 131.9, 131.4, 130.1, 129.6, 129.6, 126.7, 123.2, 90.8, 70.1, 56.6, 52.1, 31.5, 31.3, 28.5, 28.3;

HRMS (ESI)  $m/z$ : calcd for C<sub>25</sub>H<sub>27</sub>BrNO<sub>5</sub>: 502.1050 [M-H]<sup>-</sup>; found: 502.1059.

**3-(Adamantan-1-ylamino)-3-(4-bromobenzoyl)-4-hydroxyisochroman-1-one (4h)**



White solid, mp: 212-213 °C.

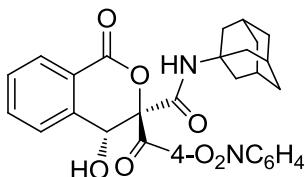
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3336, 2911, 2853, 1721, 1664, 1585, 1526, 1255, 1116, 840, 701.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.17–8.12 (m, 1H, ArH), 7.96–7.90 (m, 2H, ArH), 7.72–7.67 (m, 1H, ArH), 7.66–7.61 (m, 2H, ArH), 7.60–7.51 (m, 2H, ArH), 6.16 (s, 1H, NH), 5.74 (s, 1H, CH), 4.98 (s, 1H, OH), 2.02 (s, 3H, CH), 1.85 (s, 6H, CH<sub>2</sub>), 1.61 (s, 6H, CH<sub>2</sub>).

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  194.1, 168.3, 162.3, 140.4, 134.9, 134.1, 132.0, 131.2, 130.4, 129.6, 129.4, 124.4, 123.1, 81.7, 73.0, 52.8, 41.1, 36.1, 29.3;

HRMS (ESI) *m/z*: calcd for C<sub>26</sub>H<sub>25</sub>BrNO<sub>4</sub>: 496.0945 [M-H]<sup>-</sup>; found: 496.0956.

### 3-(Adamantan-1-ylamino)-4-hydroxy-3-(4-nitrobenzoyl)isochroman-1-one (4i)



White solid, mp: 230-232 °C.

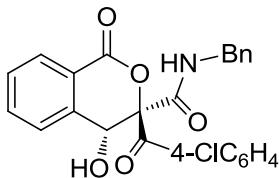
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3331, 2909, 2850, 1738, 1655, 1528, 1346, 1258, 1129, 852, 691.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.34 (d, *J* = 8.8 Hz, 2H, ArH), 8.20 (d, *J* = 8.8 Hz, 3H, ArH), 7.74–7.68 (m, 1H), 7.60 (t, *J* = 7.6 Hz, 1H, ArH), 7.46 (d, *J* = 7.6 Hz, 1H, ArH), 6.69 (s, 1H, OH), 6.31 (s, 1H, NH), 4.72 (s, 1H, CH), 2.11 (s, 3H, CH), 2.03 (s, 4H, CH<sub>2</sub>), 1.70 (s, 6H, CH<sub>2</sub>), 1.58 (s, 2H, CH<sub>2</sub>);

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  194.0, 169.0, 162.4, 151.0, 139.1, 138.5, 135.1, 130.8, 130.3, 125.1, 124.1, 123.9, 100.0, 78.6, 73.8, 53.0, 41.3, 36.1, 29.3;

HRMS (ESI) *m/z*: calcd for C<sub>26</sub>H<sub>25</sub>N<sub>2</sub>O<sub>6</sub>: 461.1713 [M-H]<sup>-</sup>; found: 461.1712.

### *N*-Benzyl-3-(4-chlorobenzoyl)-4-hydroxy-1-oxoisochroman-3-carboxamide (4j)



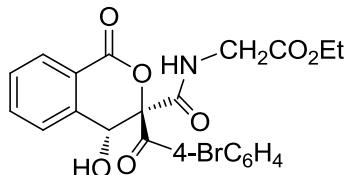
White solid, mp: 178-179 °C.

IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3065, 1754, 1674, 1538, 1258, 1229, 1121, 1091, 1014, 829, 693.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.00 (d, *J* = 6.8 Hz, 1H, ArH), 7.97–7.84 (m, 2H, ArH), 7.70 (m, 1H, ArH), 7.63 (d, *J* = 7.6 Hz, 1H, ArH), 7.50 (m, 1H, ArH), 7.40–7.34 (m, 2H, ArH), 7.27 (d, *J* = 1.8 Hz, 2H, ArH), 7.25 (s, 1H, NH), 7.12–6.98 (m, 3H, ArH), 5.53 (s, 1H, CH), 4.53 (m, 1H, CH), 4.35 (m, 1H, CH), 3.73 (s, 1H, OH);

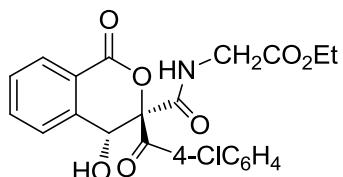
<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 194.2, 164.6, 161.7, 140.9, 138.8, 136.9, 135.2, 132.6, 131.4, 130.3, 129.7, 129.0, 128.8, 128.0, 127.7, 126.4, 122.6, 89.9, 70.3, 44.0.  
 HRMS (ESI) *m/z*: calcd for C<sub>24</sub>H<sub>17</sub>ClNO<sub>5</sub>: 434.0796 [M-H]<sup>-</sup>; found: 434.0794.

**Ethyl 2-(3-(4-bromobenzoyl)-4-hydroxy-1-oxoisochroman-3-carboxamido)acetate (4k)**



White solid, mp: 175–177 °C;  
 IR (KBr, *v*, cm<sup>-1</sup>): 3372, 2986, 1744, 1691, 1581, 1541, 1282, 1233, 1089, 840, 770;  
<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.96 (d, *J* = 6.8 Hz, 1H, ArH), 7.92–7.84 (m, 2H, ArH), 7.74–7.66 (m, 2H, ArH), 7.64–7.53 (m, 3H, ArH), 7.51–7.46 (m, 1H, NH), 5.75 (s, 1H, CH), 4.27 (s, 1H, OH), 4.25–4.15 (m, 3H, CH<sub>2</sub>), 4.02 (m, 1H, CH<sub>2</sub>), 1.27 (t, *J* = 7.2 Hz, 3H, CH<sub>3</sub>);  
<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 190.7, 169.7, 166.2, 161.4, 138.7, 135.3, 132.1, 132.0, 131.4, 130.4, 129.8, 128.2, 122.4, 90.6, 68.2, 62.2, 41.7, 14.1;  
 HRMS (ESI) *m/z*: calcd for C<sub>21</sub>H<sub>17</sub>BrNO<sub>7</sub>: 474.0189 [M-H]<sup>-</sup>; found: 474.0186.

**Ethyl 2-(3-(4-chlorobenzoyl)-4-hydroxy-1-oxoisochroman-3-carboxamido)acetate (4l)**

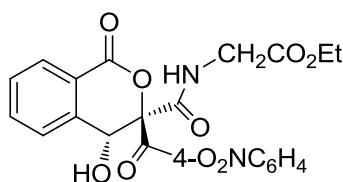


White solid, mp: 163–165 °C.  
 IR (KBr, *v*, cm<sup>-1</sup>): 3374, 2988, 1744, 1692, 1586, 1541, 1380, 1233, 1112, 842, 770;  
<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.96 (m, 3H, ArH), 7.78 (t, *J* = 6.0 Hz, 1H, ArH), 7.68 (m, 1H, ArH), 7.59 (d, *J* = 7.4 Hz, 1H, ArH), 7.48 (m, 1H, NH), 7.39 (d, *J* = 8.8 Hz, 2H, ArH), 5.76 (d, *J* = 3.0 Hz, 1H, CH), 4.35 (s, 1H, OH), 4.28–4.12 (m, 3H, CH<sub>2</sub>), 4.03 (m, 1H, CH<sub>2</sub>), 1.26 (t, *J* = 7.2 Hz, 3H, CH<sub>3</sub>);  
<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 190.5, 169.7, 166.2, 161.4, 140.8, 138.7, 135.3, 131.6, 131.4, 130.4, 129.8, 129.1, 128.2, 122.4, 90.6, 68.2, 62.2, 41.7, 14.1;  
 HRMS (ESI) *m/z*: calcd for C<sub>21</sub>H<sub>17</sub>ClNO<sub>7</sub>: 430.0694 [M-H]<sup>-</sup>; found: 430.0695.

**Ethyl 2-(4-hydroxy-3-(4-nitrobenzoyl)-1-oxoisochroman-3-carboxamido)acetate (4m)**

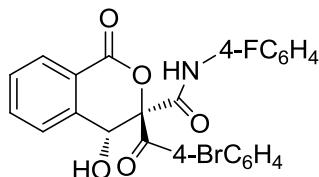
White solid, mp: 184–186 °C.

IR (KBr, *v*, cm<sup>-1</sup>): 3372, 2988, 1746, 1699, 1530, 1382, 1350, 1280, 1024, 833, 769.



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.25 (d, *J* = 9.0 Hz, 2H, ArH), 8.14 (d, *J* = 9.0 Hz, 2H, ArH), 7.96 (d, *J* = 7.2 Hz, 1H, ArH), 7.75 (m, 2H, ArH), 7.61 (d, *J* = 7.2 Hz, 1H, NH), 7.51 (t, *J* = 7.6 Hz, 1H, ArH), 5.75 (s, 1H, CH), 4.42–4.14 (m, 4H, OH and CH<sub>2</sub>), 4.06 (m, 1H, CH<sub>2</sub>), 1.28 (t, *J* = 7.2 Hz, 3H, CH<sub>3</sub>);  
<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 190.6, 169.8, 165.9, 161.1, 150.6, 138.5, 138.0, 135.6, 130.9, 130.5, 130.0, 128.3, 123.8, 122.3, 90.6, 68.0, 62.4, 41.7, 14.1;  
HRMS (ESI) *m/z*: calcd for C<sub>21</sub>H<sub>17</sub>N<sub>2</sub>O<sub>9</sub>: 441.0934 [M-H]<sup>-</sup>; found: 441.0958.

### 3-(4-Bromobenzoyl)-*N*-(4-fluorophenyl)-4-hydroxy-1-oxoisochroman-3-carboxamide (4n)



White solid, mp: 198–199 °C.

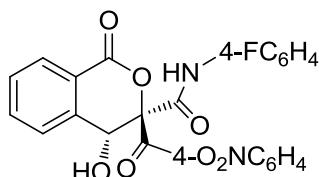
IR (KBr, *v*, cm<sup>-1</sup>): 1728, 1672, 1543, 1509, 1411, 1283, 1211, 1120, 940, 831, 763.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.80 (s, 1H, NH), 8.13–7.92 (m, 3H, Ar), 7.69 (t, *J* = 6.8 Hz, 1H, Ar), 7.67–7.55 (m, 3H, Ar), 7.55–7.42 (m, 3H, Ar), 7.06 – 6.97 (m, 2H, Ar), 5.88 (s, 1H, CH), 3.56 (s, 1H, OH);

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 190.6, 162.6 (<sup>1</sup>J<sub>CF</sub> = 241.0 Hz), 160.7, 158.5, 140.3, 135.1, 133.4 (<sup>4</sup>J<sub>CF</sub> = 2.5 Hz), 132.2, 131.9, 131.2, 129.7, 129.2, 129.1, 128.3, 122.6 (<sup>3</sup>J<sub>CF</sub> = 8.0 Hz), 122.4, 115.3 (<sup>2</sup>J<sub>CF</sub> = 22.3 Hz), 91.4, 67.0;

HRMS (ESI) *m/z*: calcd for C<sub>23</sub>H<sub>15</sub>BrFNO<sub>5</sub>: 482.0040 [M-H]<sup>-</sup>; found: 482.0042;

### *N*-(4-Fluorophenyl)-4-hydroxy-3-(4-nitrobenzoyl)-1-oxoisochroman-3-carboxamide (4o)



White solid, mp: 190–191 °C.

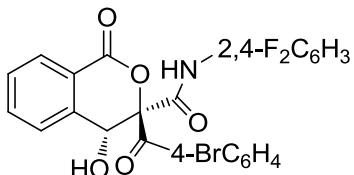
IR (KBr, *v*, cm<sup>-1</sup>): 1729, 1672, 1543, 1509, 1411, 1283, 1211, 1120, 1010, 845, 697.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.79 (s, 1H, NH), 8.09–7.93 (m, 3H, ArH), 7.68 (d, *J* = 6.8 Hz, 1H, ArH), 7.67–7.55 (m, 3H, ArH), 7.55–7.43 (m, 3H, ArH), 7.02 (t, *J* = 8.6 Hz, 2H, ArH), 5.87 (s, 1H, CH), 3.54 (s, 1H, OH).

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 188.5, 161.5 (<sup>1</sup>J<sub>CF</sub> = 248.0 Hz), 139.4, 134.2, 132.4 (<sup>4</sup>J<sub>CF</sub> = 2.6 Hz), 132.1, 132.0, 130.4, 129.9, 128.9, 128.4, 127.9, 127.4, 121.9 (<sup>3</sup>J<sub>CF</sub> = 7.9 Hz), 121.4, 114.4 (<sup>2</sup>J<sub>CF</sub> = 22.1 Hz), 114.5, 90.2, 65.9.

HRMS (ESI) *m/z*: calcd for C<sub>23</sub>H<sub>14</sub>FN<sub>2</sub>O<sub>7</sub>: 449.0780 [M-H]<sup>-</sup>; found: 449.0785.

### 3-(4-Bromobenzoyl)-*N*-(2,4-difluorophenyl)-4-hydroxy-1-oxoisochroman-3-carboxamide (4p)



White solid, mp: 192–193 °C.

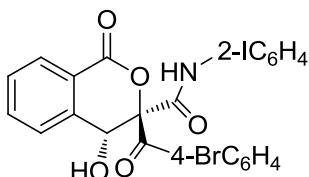
IR (KBr, *v*, cm<sup>-1</sup>): 1746, 1694, 1529, 1277, 1229, 1114, 1085, 1010, 855, 765.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 9.00 (s, 1H, NH), 8.11–7.88 (m, 4H, ArH), 7.76–7.55 (m, 4H, ArH), 7.50 (t, *J* = 7.4 Hz, 1H, ArH), 6.93–6.76 (m, 2H, ArH), 5.87 (s, 1H, CH), 3.73 (s, 1H, OH).

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 191.2, 171.3, 162.3 (<sup>1</sup>J<sub>CF</sub> = 232.5 Hz), 152.1, 138.1, 135.3, 132.2, 131.9, 131.7, 130.4, 130.1, 129.8, 127.0, 123.8 (<sup>4</sup>J<sub>CF</sub> = 7.8), 122.6, 111.5 (<sup>6</sup>J<sub>CF</sub> = 3.6 Hz), 111.3 (<sup>5</sup>J<sub>CF</sub> = 3.8 Hz), 104.2 (<sup>3</sup>J<sub>CF</sub> = 23.0 Hz), 103.9 (<sup>2</sup>J<sub>CF</sub> = 23.2 Hz), 90.0, 68.3.

HRMS (ESI) *m/z*: calcd for C<sub>23</sub>H<sub>14</sub>BrF<sub>2</sub>NO<sub>5</sub>: 501.9923 [M-H]<sup>-</sup>; found: 501.9942.

### 3-(4-Bromobenzoyl)-4-hydroxy-*N*-(2-iodophenyl)-1-oxoisochroman-3-carboxamide (4q)



White solid, mp: 179–181 °C.

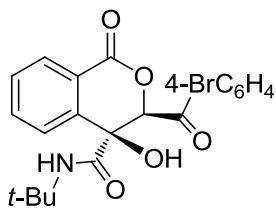
IR (KBr, *v*, cm<sup>-1</sup>): 3310, 1742, 1693, 1579, 1520, 1434, 1257, 1111, 1073, 853, 751.

<sup>1</sup>H NMR (400 MHz, Acetone) δ 9.12 (s, 1H, NH), 8.10–7.99 (m, 3H, ArH), 7.98–7.90 (m, 1H, ArH), 7.83–7.77 (m, 1H, ArH), 7.71–7.64 (m, 2H, ArH), 7.64 – 7.55 (m, 2H, ArH), 7.53–7.46 (m, 1H, ArH), 7.32–7.26 (m, 1H, ArH), 6.92–6.85 (m, 1H, ArH), 5.90 (d, *J* = 3.5 Hz, 1H, CH), 3.76 (d, *J* = 4.4 Hz, 1H, OH);

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 191.2, 163.4, 160.9, 139.2, 138.1, 137.0, 135.3, 132.2, 132.0, 131.7, 130.4, 130.2, 129.7, 129.2, 127.2, 127.2, 122.7, 122.6, 90.8, 90.2, 68.3;

HRMS (ESI) *m/z*: calcd for C<sub>23</sub>H<sub>14</sub>BrINO<sub>5</sub>: 591.9077 [M-H]<sup>-</sup>; found: 591.9081.

**3-(4-Bromobenzoyl)-*N*-(*tert*-butyl)-4-hydroxy-1-oxoisochroman-4-carboxamide (5a)**



White solid, mp: 186–187 °C.

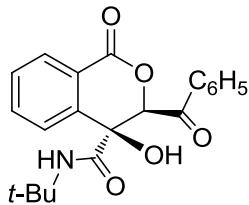
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3371, 3073, 2927, 1736, 1655, 1587, 1531, 1458, 1118, 1007, 970, 746.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.17 (d,  $J$  = 7.6 Hz, 1H, ArH), 7.90 (d,  $J$  = 8.4 Hz, 2H, ArH), 7.72–7.53 (m, 4H, ArH), 7.40 (d,  $J$  = 7.6 Hz, 1H, ArH), 6.95 (s, 1H, NH), 6.29 (s, 1H, CH), 5.03 (s, 1H, OH), 1.37 (s, 9H, CH<sub>3</sub>);

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 194.4, 169.5, 162.7, 138.9, 134.9, 133.2, 132.3, 131.1, 130.7, 130.6, 130.1, 125.0, 124.2, 77.4, 74.0, 52.1, 28.5;

HRMS (ESI)  $m/z$ : calcd for C<sub>21</sub>H<sub>19</sub>BrNO<sub>5</sub>: 406.0424 [M-H]<sup>-</sup>; found: 406.0458.

**3-Benzoyl-*N*-(*tert*-butyl)-4-hydroxy-1-oxoisochroman-4-carboxamide (5b)**



White solid, mp: 197–199 °C.

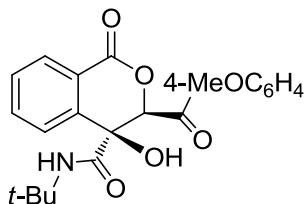
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3372, 3126, 2976, 1731, 1655, 1530, 1447, 1367, 1259, 1123, 969.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.20 (d,  $J$  = 7.6 Hz, 1H, ArH), 8.05 (d,  $J$  = 7.6 Hz, 2H, ArH), 7.70–7.63 (m, 2H, ArH), 7.58 (t,  $J$  = 7.2 Hz, 1H, ArH), 7.51 (t,  $J$  = 7.8 Hz, 2H, ArH), 7.42 (d,  $J$  = 7.6 Hz, 1H, ArH), 6.99 (s, 1H, NH), 6.36 (s, 1H, CH), 5.15 (s, 1H, OH), 1.38 (s, 9H, CH<sub>3</sub>).

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 195.5, 169.6, 162.9, 139.0, 135.0, 134.8, 134.4, 130.8, 130.1, 129.8, 128.9, 125.0, 124.3, 76.9, 74.1, 52.0, 28.5;

HRMS (ESI)  $m/z$ : calcd for C<sub>21</sub>H<sub>20</sub>NO<sub>5</sub>: 366.1336 [M-H]<sup>-</sup>; found: 366.1330.

***N*-(*tert*-Butyl)-4-hydroxy-3-(4-methoxybenzoyl)-1-oxoisochroman-4-carboxamide (5c)**



White solid, mp: 181–182 °C.

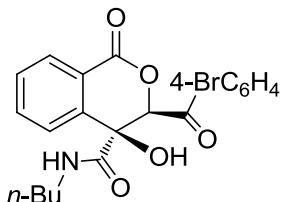
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3371, 3154, 2964, 1741, 1695, 1600, 1514, 1245, 1130, 1020, 612.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.22 – 8.15 (m, 1H, ArH), 8.04 (d, *J* = 8.8 Hz, 2H, ArH), 7.71 – 7.64 (m, 1H, ArH), 7.60 – 7.54 (m, 1H, ArH), 7.40 (d, *J* = 7.6 Hz, 1H, ArH), 7.07 (s, 1H, NH), 6.96 (d, *J* = 8.9 Hz, 2H, ArH), 6.33 (s, 1H, CH), 5.45 (s, 1H, OH), 3.89 (s, 3H, OCH<sub>3</sub>), 1.37 (s, 9H, CH<sub>3</sub>).

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 193.7, 169.7, 165.2, 163.1, 139.3, 134.8, 132.4, 130.7, 130.0, 127.4, 125.0, 124.4, 114.2, 76.3, 74.3, 55.7, 51.9, 28.5;

HRMS (ESI) *m/z*: calcd for C<sub>22</sub>H<sub>22</sub>NO<sub>6</sub>: 396.1441 [M-H]<sup>-</sup>; found: 396.1446.

### 3-(4-Bromobenzoyl)-*N*-butyl-4-hydroxy-1-oxoisochroman-4-carboxamide (5d)



White solid, mp: 196–197 °C;

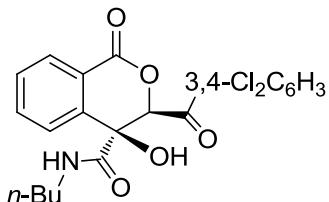
IR (KBr, *v*, cm<sup>-1</sup>): 3399, 3200, 2962, 1729, 1638, 1362, 1259, 1124, 1009, 826, 557.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.22–8.16 (m, 1H, ArH), 7.89 (d, *J* = 8.6 Hz, 2H, ArH), 7.70–7.62 (m, 3H, ArH), 7.60–7.54 (m, 1H, ArH), 7.38 (d, *J* = 7.6 Hz, 1H, ArH), 7.02 (s, 1H, NH), 6.28 (s, 1H, CH), 5.08 (s, 1H, OH), 3.39–3.31 (m, 2H, CH<sub>2</sub>), 1.56–1.46 (m, 2H, CH<sub>2</sub>), 1.40–1.30 (m, 2H, CH<sub>2</sub>), 0.93 (t, *J* = 7.2 Hz, 3H, CH<sub>3</sub>).

<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 194.3, 170.3, 162.7, 138.5, 134.9, 133.2, 132.3, 131.1, 130.7, 130.6, 130.2, 125.1, 124.2, 77.2, 74.1, 39.7, 31.4, 20.0, 13.7;

HRMS (ESI) *m/z*: calcd for C<sub>21</sub>H<sub>19</sub>BrNO<sub>5</sub>: 444.0447 [M-H]<sup>-</sup>; found: 444.0478.

### *N*-Butyl-3-(3,4-dichlorobenzoyl)-4-hydroxy-1-oxoisochroman-4-carboxamide (5e)



White solid, mp: 178–179 °C.

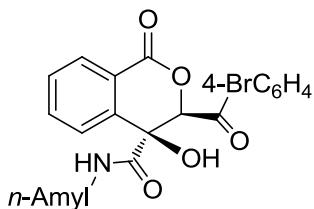
IR (KBr, *v*, cm<sup>-1</sup>): 3352, 2956, 1724, 1673, 1525, 1372, 1257, 1139, 1028, 765, 696.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.20 (d, *J* = 7.6 Hz, 1H, ArH), 8.09 (d, *J* = 2.0 Hz, 1H, ArH), 7.90–7.81 (m, 1H, ArH), 7.68 (t, *J* = 7.2 Hz, 1H, ArH), 7.62–7.56 (m, 2H, ArH), 7.38 (d, *J* = 7.6 Hz, 1H, ArH), 6.97 (s, 1H, NH), 6.24 (s, 1H, CH), 4.95 (s, 1H, OH), 3.43–3.29 (m, 2H, CH<sub>2</sub>), 1.56–1.49 (m, 2H, CH<sub>2</sub>), 1.40–1.32 (m, 2H, CH<sub>2</sub>), 0.94 (t, *J* = 7.2 Hz, 3H, CH<sub>3</sub>);

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 193.2, 170.3, 162.5, 139.8, 138.3, 135.0, 134.1, 133.8, 131.4, 131.0, 130.7, 130.3, 128.7, 125.1, 124.1, 77.6, 73.9, 39.8, 31.4, 20.0, 13.7;

HRMS (ESI)  $m/z$ : calcd for  $C_{21}H_{18}Cl_2NO_5$ : 434.0557 [M-H]<sup>-</sup>; found: 434.0570.

**3-(4-Bromobenzoyl)-4-hydroxy-1-oxo-N-pentylisochroman-4-carboxamide (5f)**



White solid, mp: 176–177 °C.

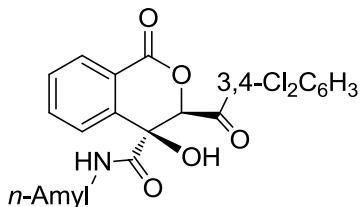
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3336, 2951, 1727, 1671, 1587, 1302, 1262, 1139, 1071, 867, 744.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.18 (d,  $J$  = 7.6 Hz, 1H, ArH), 7.88 (d,  $J$  = 8.4 Hz, 2H, ArH), 7.72–7.61 (m, 3H, ArH), 7.57 (t,  $J$  = 7.6 Hz, 1H, ArH), 7.38 (d,  $J$  = 7.6 Hz, 1H, ArH), 7.04 (s, 1H, NH), 6.28 (s, 1H, CH), 5.10 (s, 1H, OH), 3.40–3.26 (m, 2H, CH<sub>2</sub>), 1.58–1.48 (m, 2H, CH<sub>2</sub>), 1.38–1.23 (m, 4H, CH<sub>2</sub>), 0.90 (t,  $J$  = 6.6 Hz, 3H, CH<sub>3</sub>).

<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 194.3, 170.3, 162.7, 138.5, 134.9, 133.2, 132.3, 131.1, 130.6, 130.6, 130.2, 125.2, 124.2, 77.4, 74.0, 39.9, 29.0, 28.9, 22.3, 14.0;

HRMS (ESI)  $m/z$ : calcd for  $C_{22}H_{21}BrNO_5$ : 458.0603 [M-H]<sup>-</sup>; found: 458.0602.

**3-(3,4-Dichlorobenzoyl)-4-hydroxy-1-oxo-N-pentylisochroman-4-carboxamide (5g)**



White solid, mp: 182–184 °C.

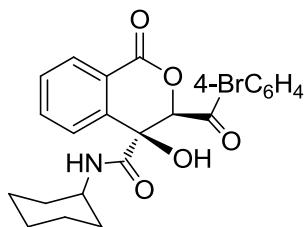
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3365, 2955, 1723, 1671, 1525, 1455, 1396, 1258, 1139, 1030, 697.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.23–8.18 (m, 1H, ArH), 8.09 (d,  $J$  = 2.0 Hz, 1H, ArH), 7.88–7.84 (m, 1H, ArH), 7.70–7.66 (m, 1H, ArH), 7.61–7.56 (m, 2H, ArH), 7.40–7.37 (m, 1H, ArH), 6.96 (s, 1H, NH), 6.24 (s, 1H, CH), 4.94 (s, 1H, OH), 3.38–3.32 (m, 2H, CH<sub>2</sub>), 1.53 (d,  $J$  = 6.8 Hz, 2H, CH<sub>2</sub>), 1.36–1.27 (m, 4H, CH<sub>2</sub>), 0.90 (t,  $J$  = 6.8 Hz, 3H, CH<sub>3</sub>);

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 193.2, 170.3, 162.4, 139.8, 138.3, 135.0, 134.9, 133.8, 131.4, 131.0, 130.7, 130.3, 128.7, 125.1, 124.1, 77.5, 73.9, 40.0, 29.0, 28.9, 22.3, 14.0;

HRMS (ESI)  $m/z$ : calcd for  $C_{22}H_{21}Cl_2NO_5$ : 448.0719 [M-H]<sup>-</sup>; found: 448.0735.

**3-(4-Bromobenzoyl)-N-cyclohexyl-4-hydroxy-1-oxoisochroman-4-carboxamide (5h)**



White solid, mp: 195–196 °C.

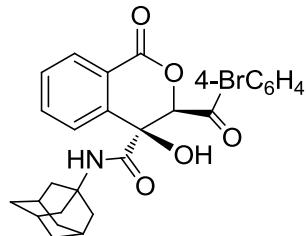
IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3384, 2930, 1732, 1650, 1531, 1455, 1257, 1122, 1069, 969, 699.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.23–8.16 (m, 1H, ArH), 7.89 (d,  $J$  = 8.2 Hz, 2H, ArH), 7.72–7.62 (m, 3H, ArH), 7.61–7.54 (m, 1H, ArH), 7.39 (d,  $J$  = 7.6 Hz, 1H, ArH), 6.98 (d,  $J$  = 8.0 Hz, 1H, NH), 6.30 (s, 1H, CH), 5.05 (s, 1H, OH), 3.85–3.75 (m, 1H, CH), 1.83–1.56 (m, 5H, CH<sub>2</sub>), 1.46–1.29 (m, 3H, CH<sub>2</sub>), 1.26–1.15 (m, 2H, CH<sub>2</sub>).

<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  194.4, 169.4, 162.7, 138.6, 134.9, 133.2, 132.3, 131.1, 130.7, 130.6, 130.2, 125.1, 124.2, 77.3, 74.0, 48.8, 33.0, 32.7, 25.3, 24.7, 24.6;

HRMS (ESI)  $m/z$ : calcd for C<sub>23</sub>H<sub>21</sub>BrNO<sub>5</sub>: 470.0603 [M-H]<sup>-</sup>; found: 470.0620.

#### N-(Adamantan-1-yl)-3-(4-bromobenzoyl)-4-hydroxy-1-oxoisochroman-4-carboxamide (5i)



White solid, mp: 215–217 °C.

IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3358, 3070, 2908, 1738, 1655, 1536, 1455, 1259, 1130, 1006, 697.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.21–8.15 (m,  $J$  = 7.6, 0.9 Hz, 1H, ArH), 7.90 (d,  $J$  = 8.6 Hz, 2H, ArH), 7.71–7.61 (m, 3H, ArH), 7.60–7.55 (m, 1H, ArH), 7.45 (d,  $J$  = 7.6 Hz, 1H, ArH), 6.79 (s, 1H, NH), 6.27 (s, 1H, CH), 5.00 (s, 1H, OH), 2.10 (s, 3H, CH), 2.02 (s, 6H, CH<sub>2</sub>), 1.69 (s, 6H, CH<sub>2</sub>);

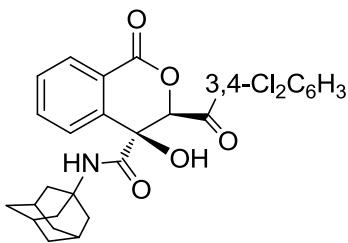
<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  194.5, 169.2, 162.7, 138.8, 134.9, 133.3, 132.3, 131.1, 130.7, 130.6, 130.1, 125.1, 124.3, 77.2, 74.0, 52.8, 41.3, 36.2, 29.4;

HRMS (ESI)  $m/z$ : calcd for C<sub>27</sub>H<sub>25</sub>BrNO<sub>5</sub>: 522.0916 [M-H]<sup>-</sup>; found: 522.0915.

#### N-(Adamantan-1-yl)-3-(3,4-dichlorobenzoyl)-4-hydroxy-1-oxoisochroman-4-carboxamide (5j)

White solid, mp: 205–206 °C.

IR (KBr,  $\nu$ , cm<sup>-1</sup>): 3295, 2909, 1714, 1669, 1524, 1311, 1232, 1136, 1032, 742, 698.

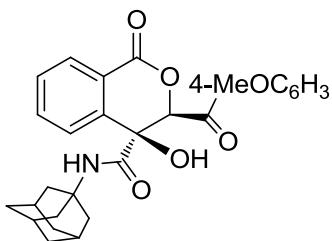


<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.18 (s, 1H, ArH), 8.11 (s, 1H, ArH), 7.87 (s, 1H, ArH), 7.68 (s, 1H, ArH), 7.58 (s, 2H, ArH), 7.45 (s, 1H, ArH), 6.76 (s, 1H, NH), 6.24 (s, 1H, CH), 4.88 (s, 1H, OH), 2.12 (s, 3H, CH), 2.03 (s, 6H, CH<sub>2</sub>), 1.70 (s, 6H, CH<sub>2</sub>);

<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 193.3, 169.1, 162.6, 139.7, 138.7, 134.9, 134.1, 133.8, 131.4, 131.0, 130.7, 130.2, 128.7, 125.1, 124.2, 77.8, 73.9, 52.9, 41.3, 36.1, 29.3;

HRMS (ESI) *m/z*: calcd for C<sub>27</sub>H<sub>24</sub>Cl<sub>2</sub>NO<sub>5</sub>: 512.1026 [M-H]<sup>-</sup>; found: 512.1025.

**N-(Adamantan-1-yl)-4-hydroxy-3-(4-methoxybenzoyl)-1-oxoisochroman-4-carboxamide (5k)**



White solid, mp: 189–190 °C.

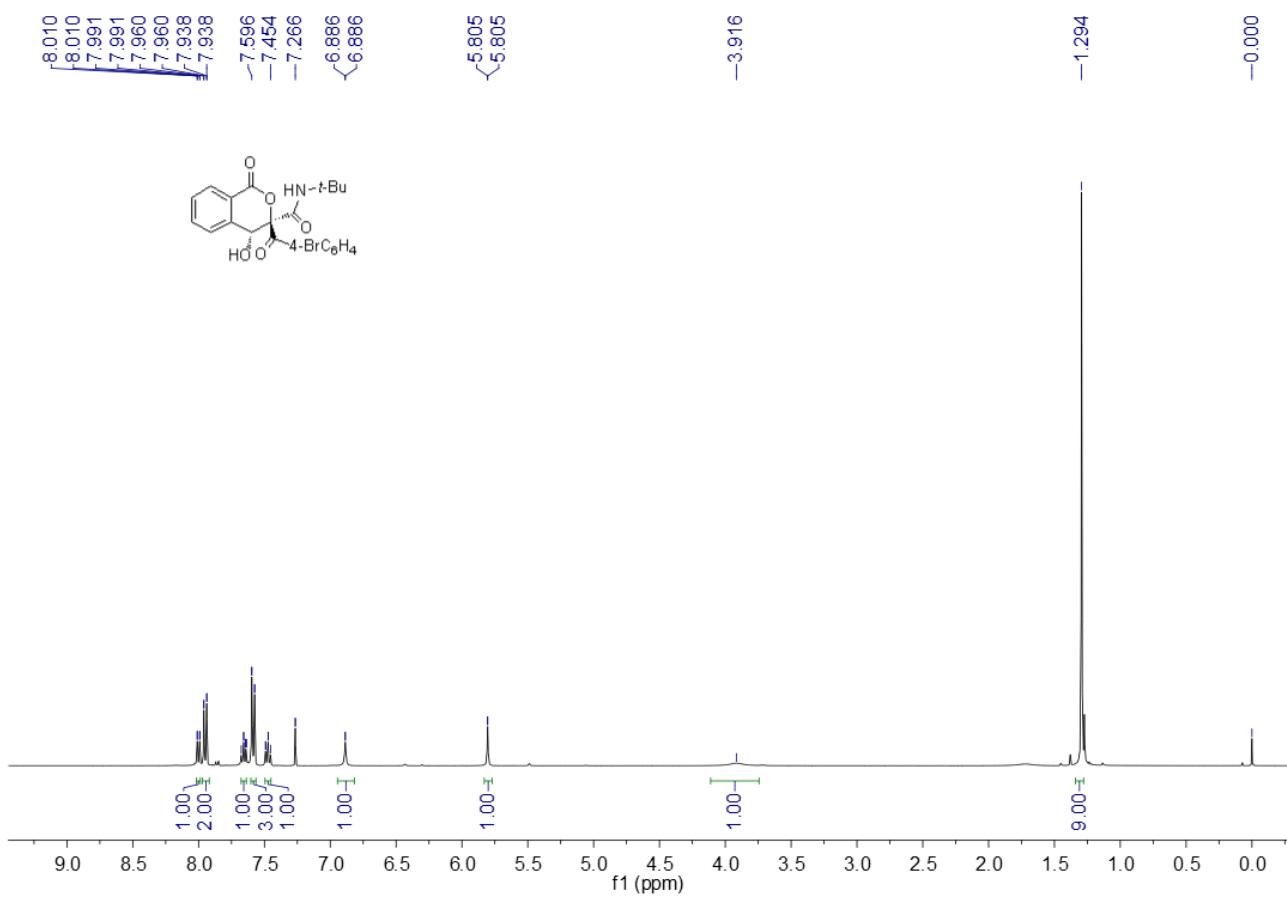
IR (KBr, *v*, cm<sup>-1</sup>): 3125, 2909, 1740, 1656, 1535, 1455, 1312, 1241, 1130, 1033, 846.

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.18 (d, *J* = 8.0 Hz, 1H, ArH), 8.04 (d, *J* = 8.8 Hz, 2H, ArH), 7.70–7.64 (m, 1H, ArH), 7.56 (t, *J* = 7.6 Hz, 1H, ArH), 7.45 (d, *J* = 7.6 Hz, 1H, ArH), 7.04–6.87 (m, 3H, ArH and NH), 6.31 (s, 1H, CH), 5.44 (s, 1H, OH), 3.89 (s, 3H, OMe), 2.09 (s, 3H, CH), 2.03 (s, 6H, CH<sub>2</sub>), 1.69 (s, 6H, CH<sub>2</sub>);

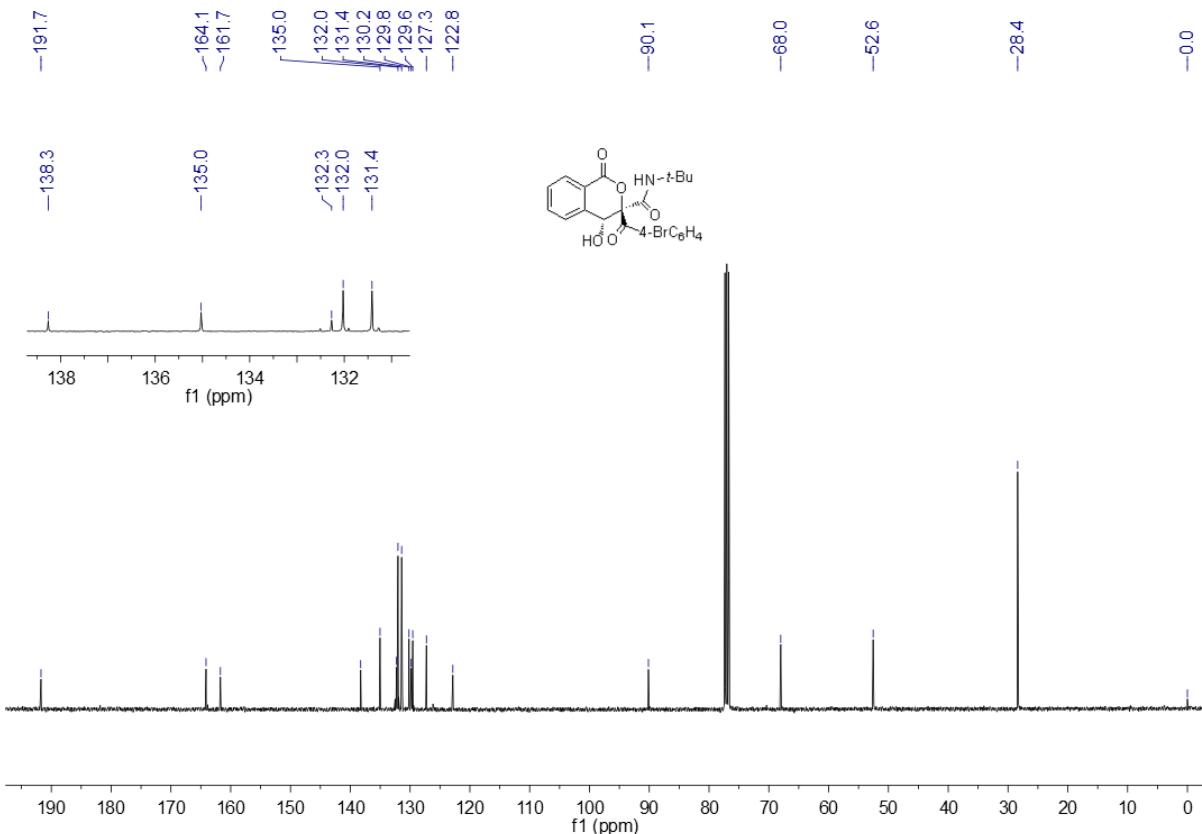
<sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 193.7, 169.4, 165.2, 163.1, 139.3, 134.7, 132.4, 130.7, 130.0, 127.4, 125.0, 124.4, 114.2, 76.4, 74.2, 55.7, 52.6, 41.3, 36.2, 29.4;

HRMS (ESI) *m/z*: calcd for C<sub>28</sub>H<sub>28</sub>NO<sub>6</sub>: 474.1911 [M-H]<sup>-</sup>; found: 474.1905.

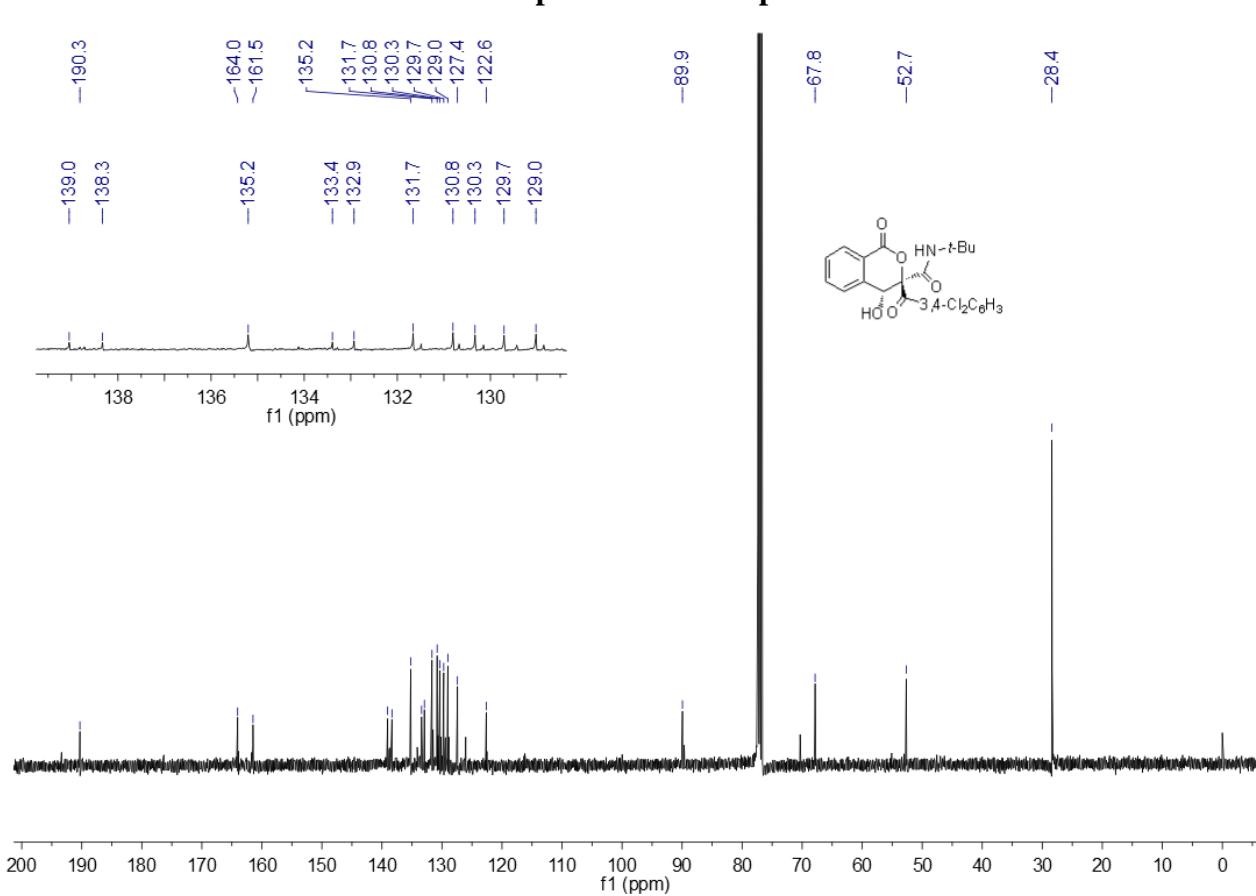
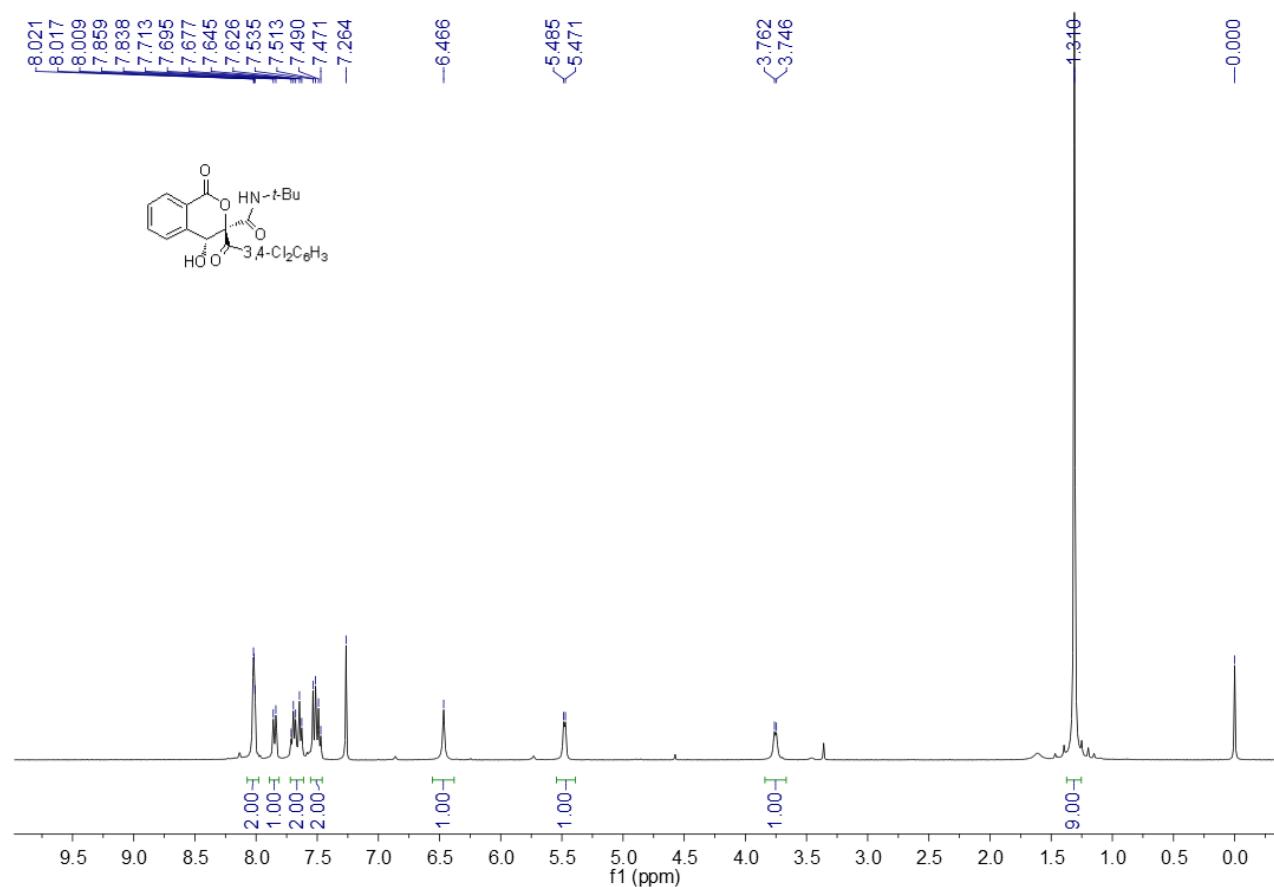
**Copies of  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR of compounds 4 and 5**

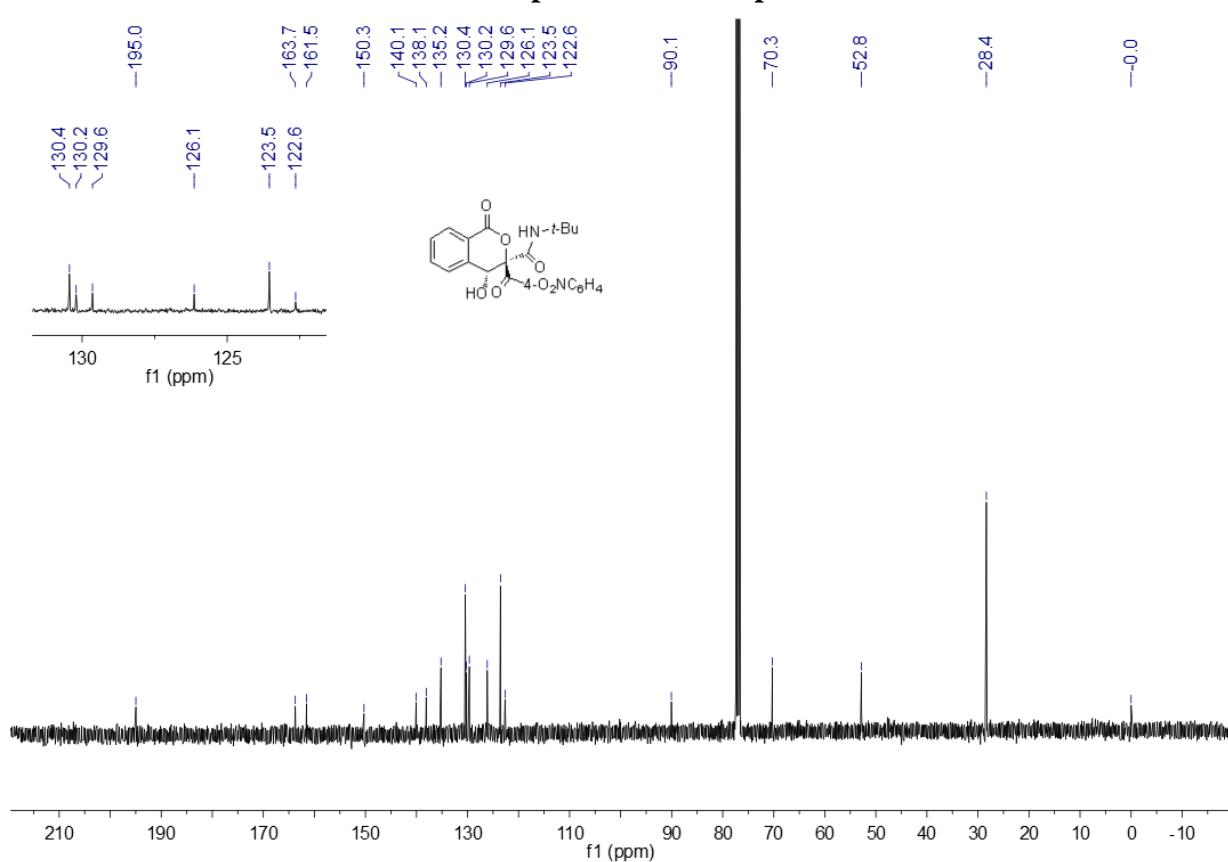
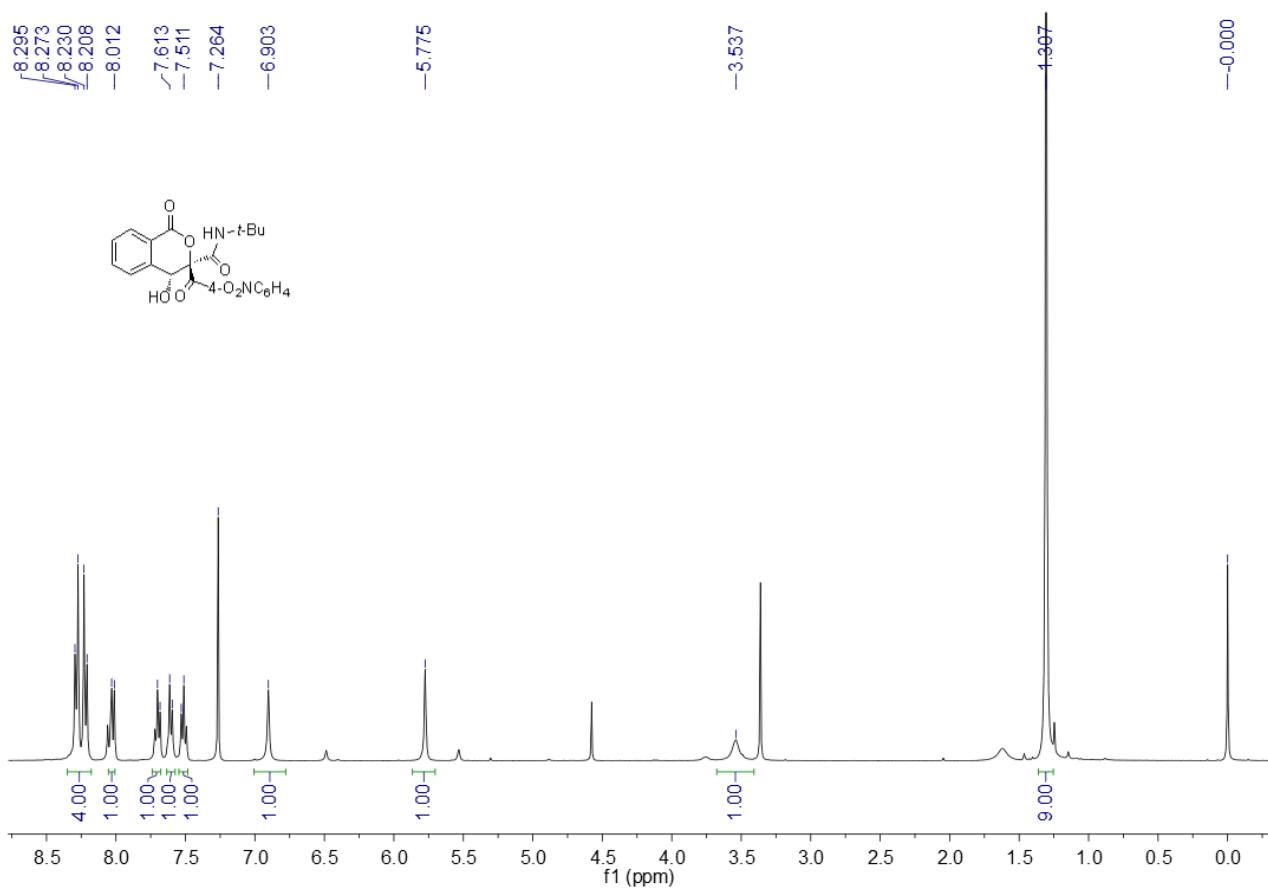


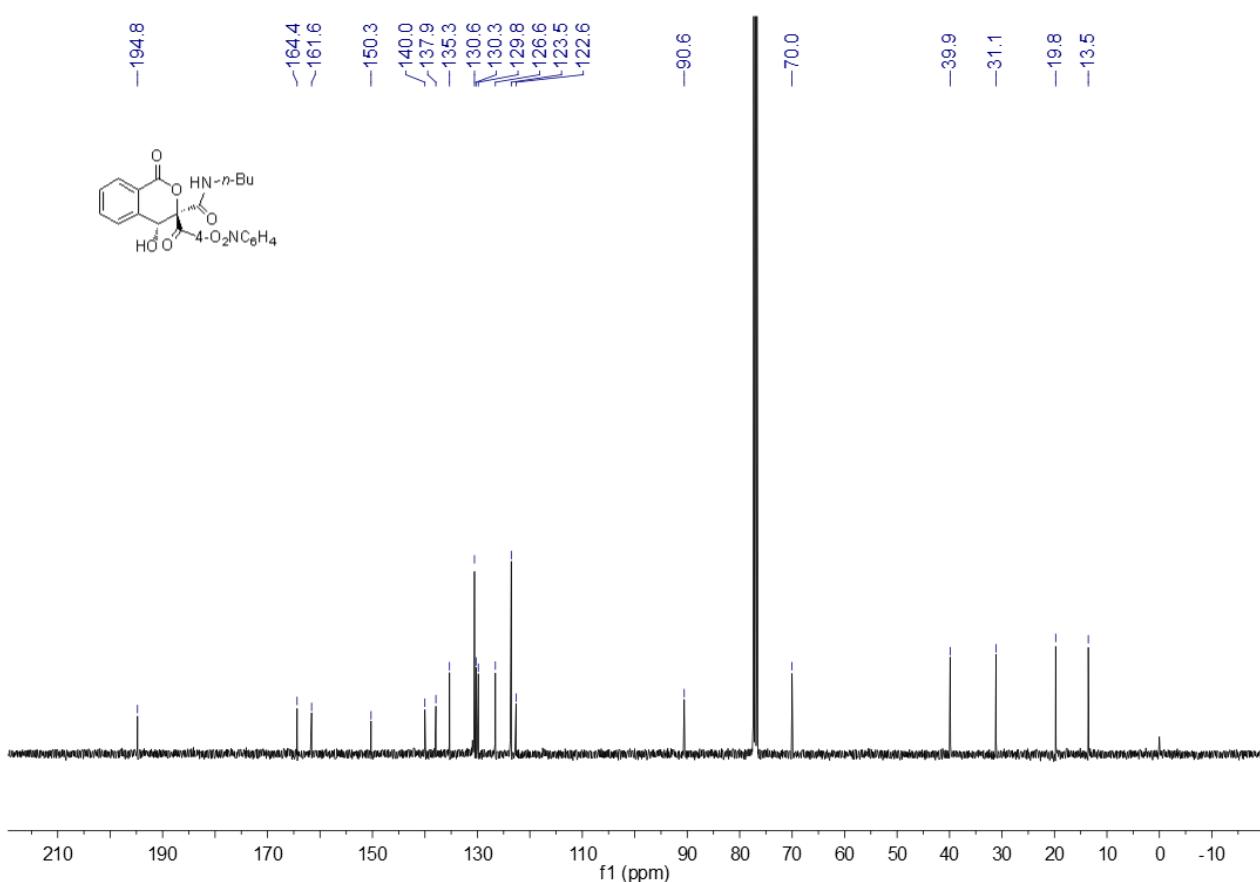
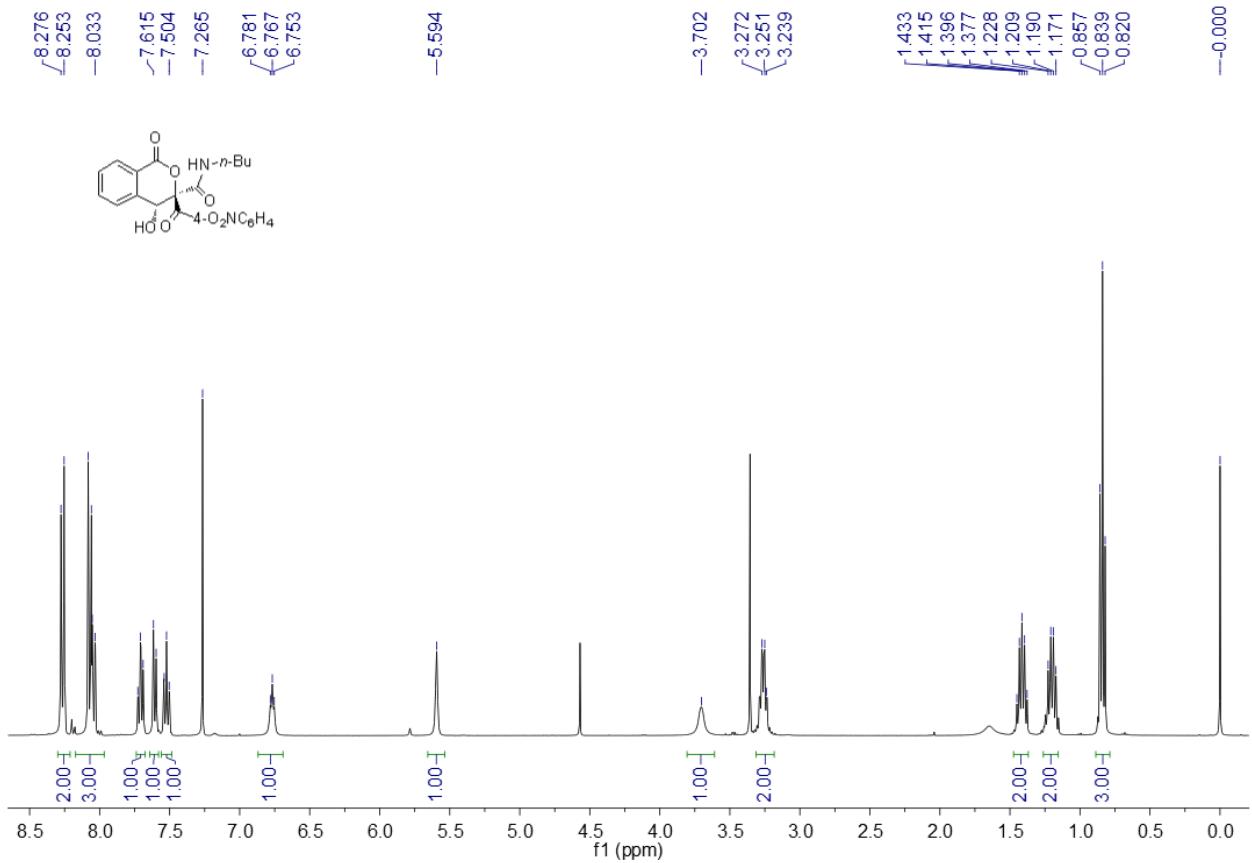
$^1\text{H}$  NMR Spectrum of Compound 4a

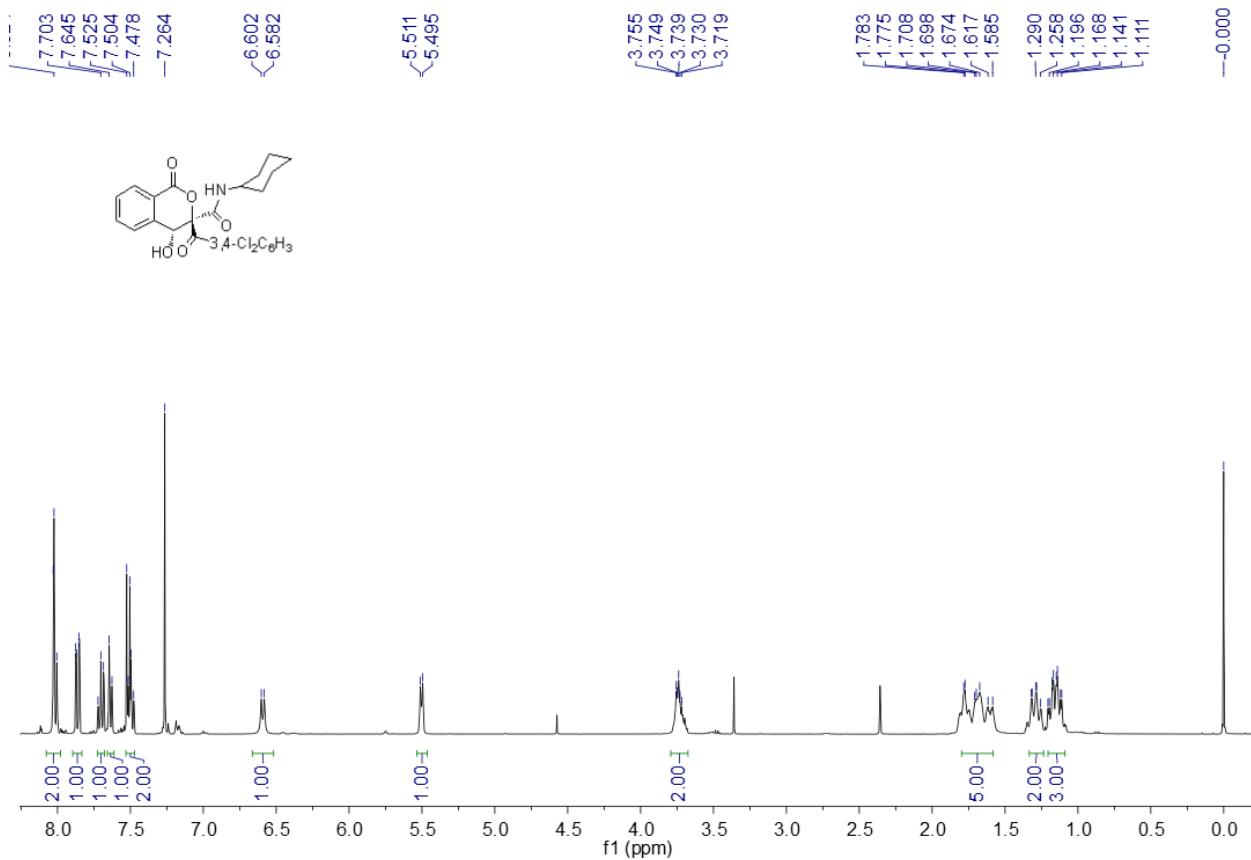


$^{13}\text{C}$  NMR Spectrum of Compound 4a

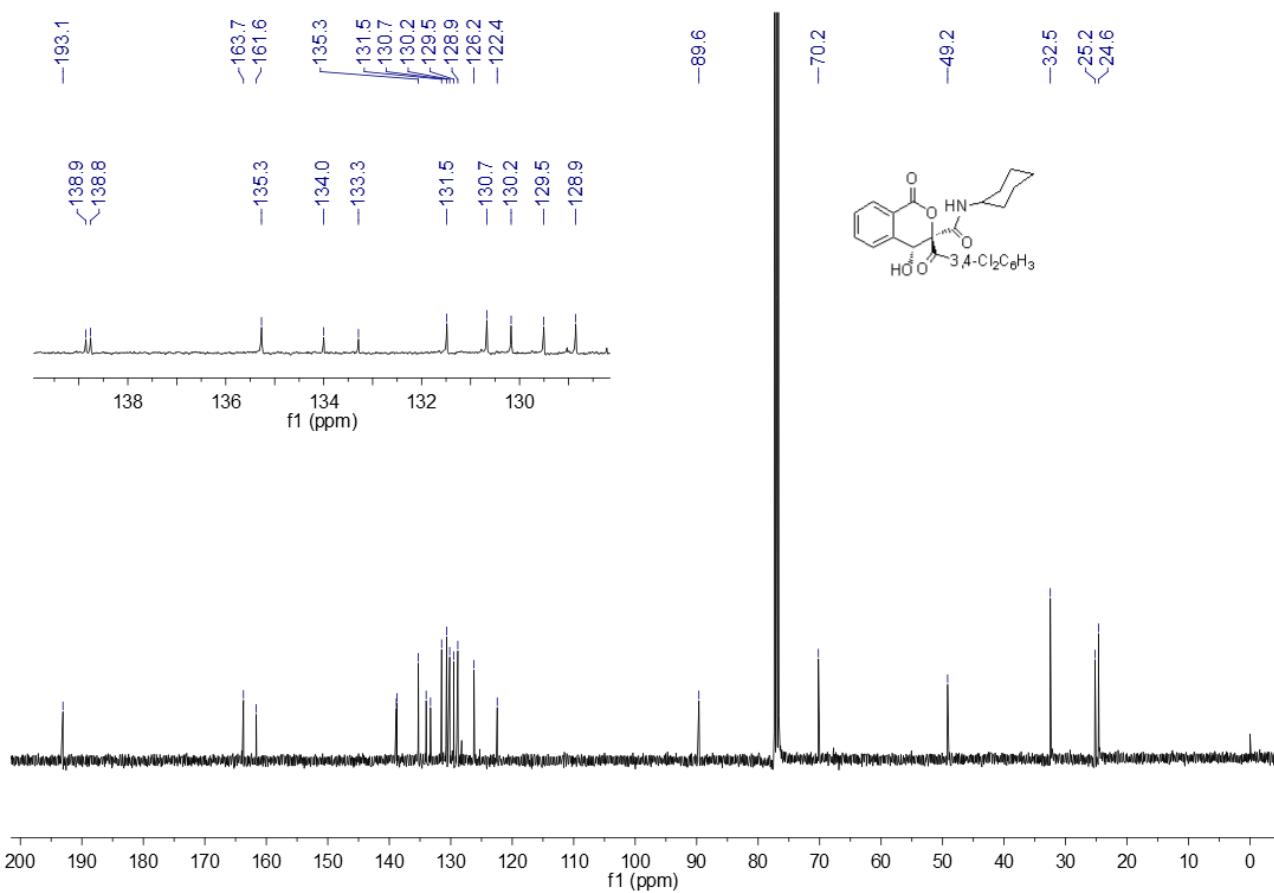




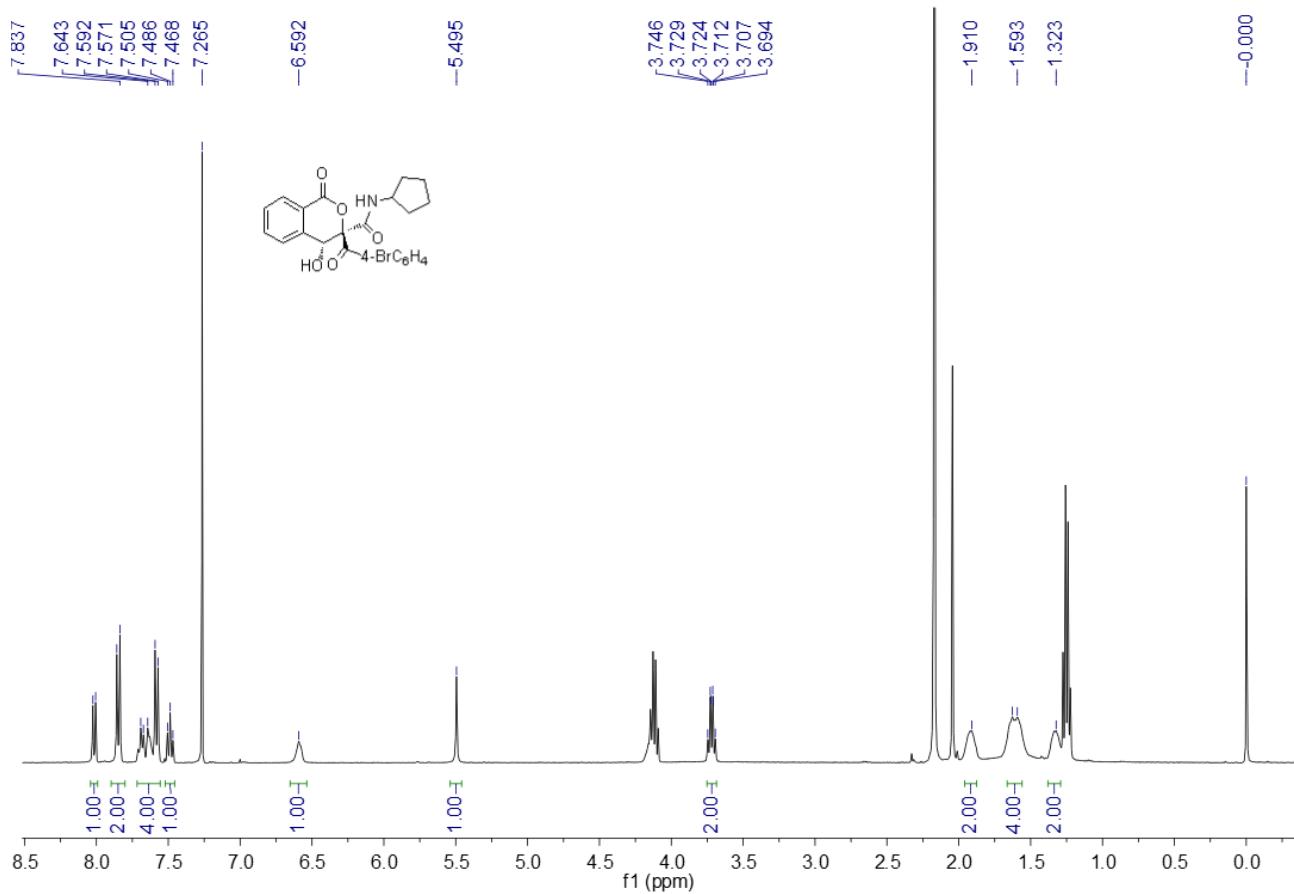




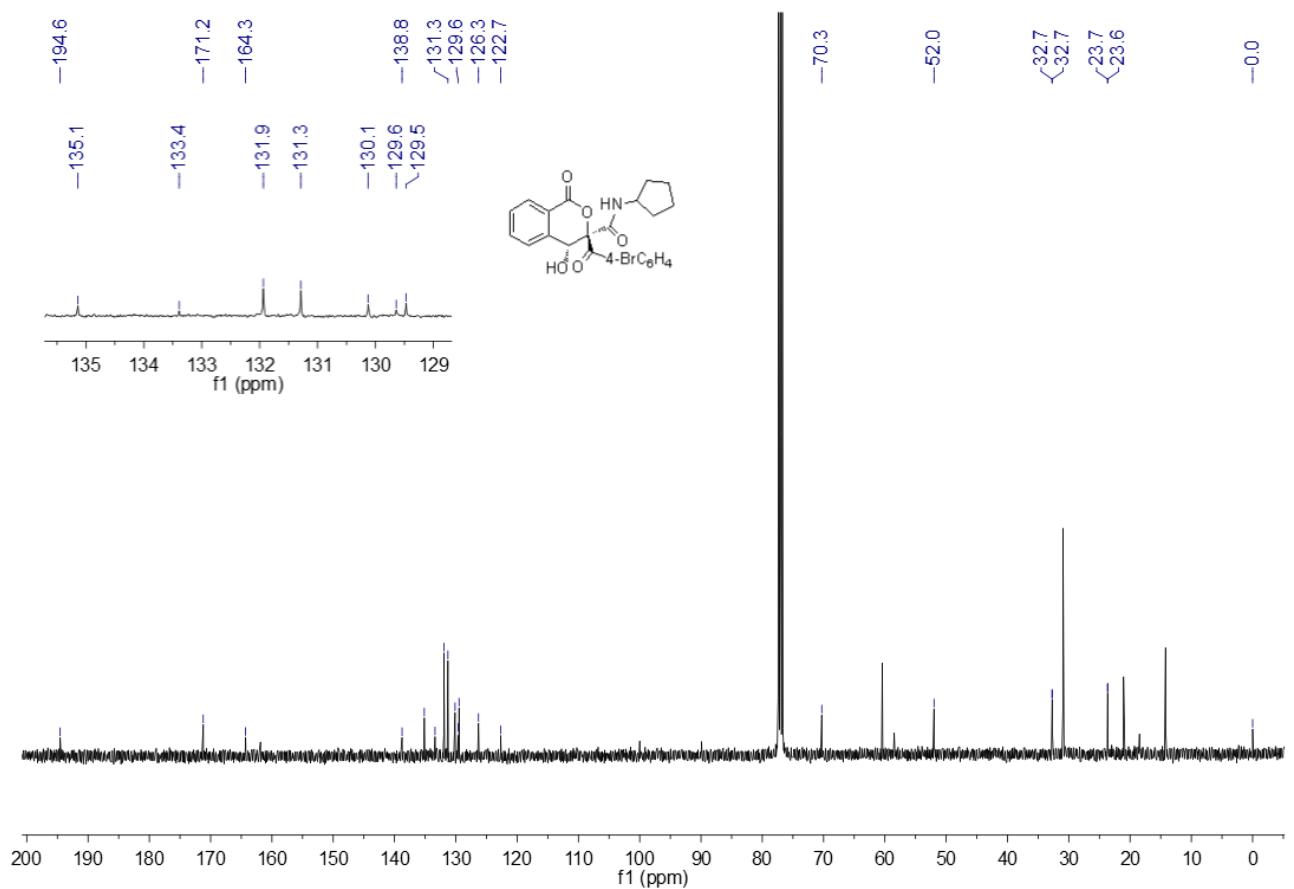
**<sup>1</sup>H NMR Spectrum of Compound 4e**



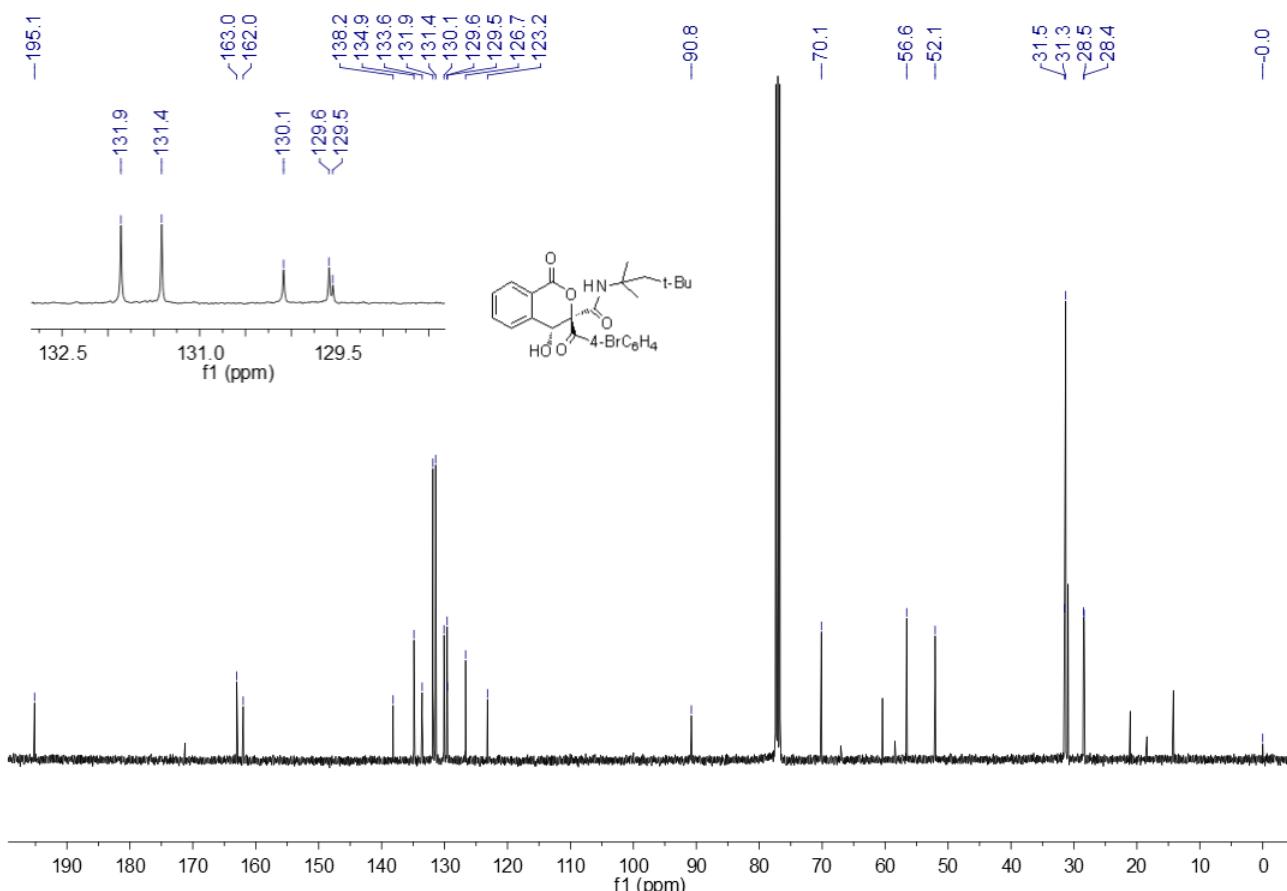
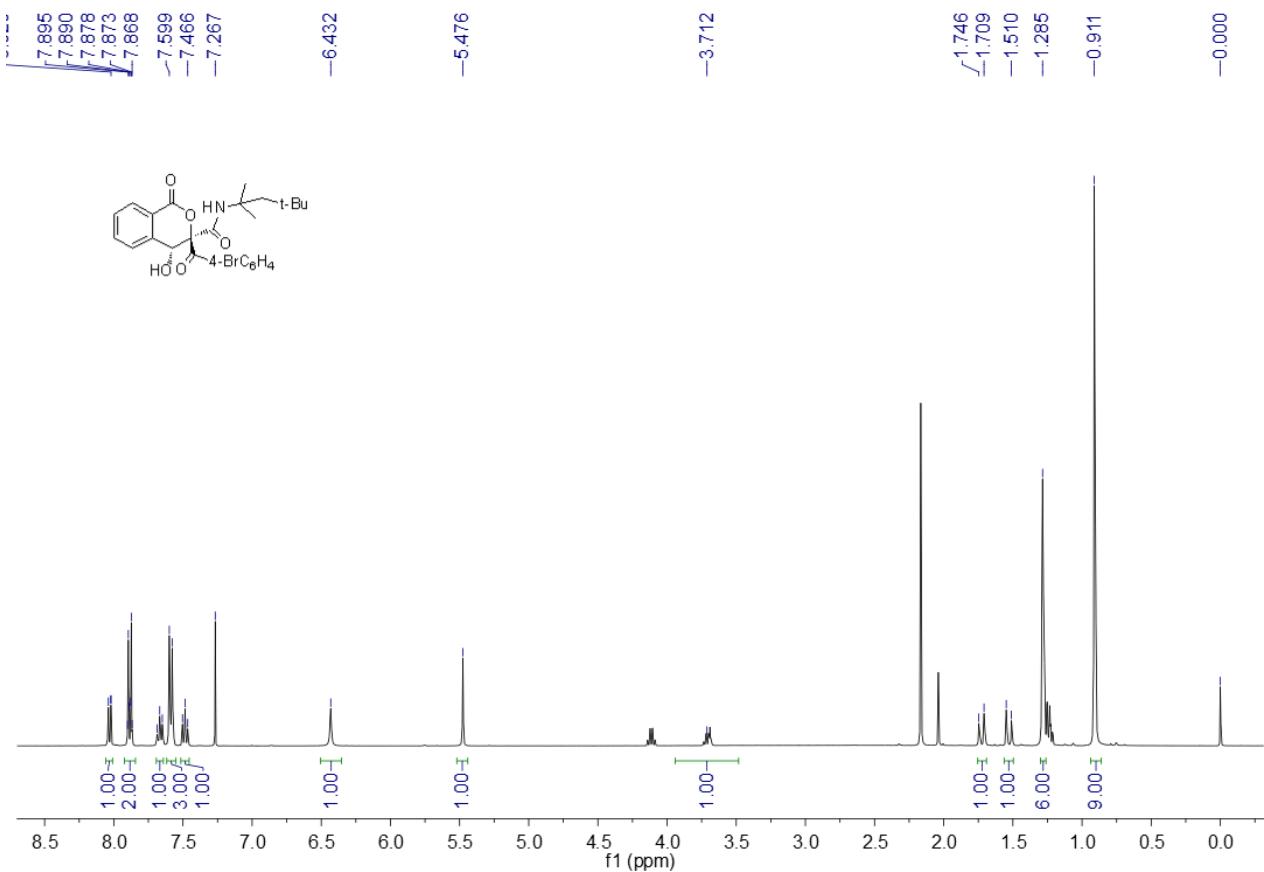
**<sup>13</sup>C NMR Spectrum of Compound 4e**

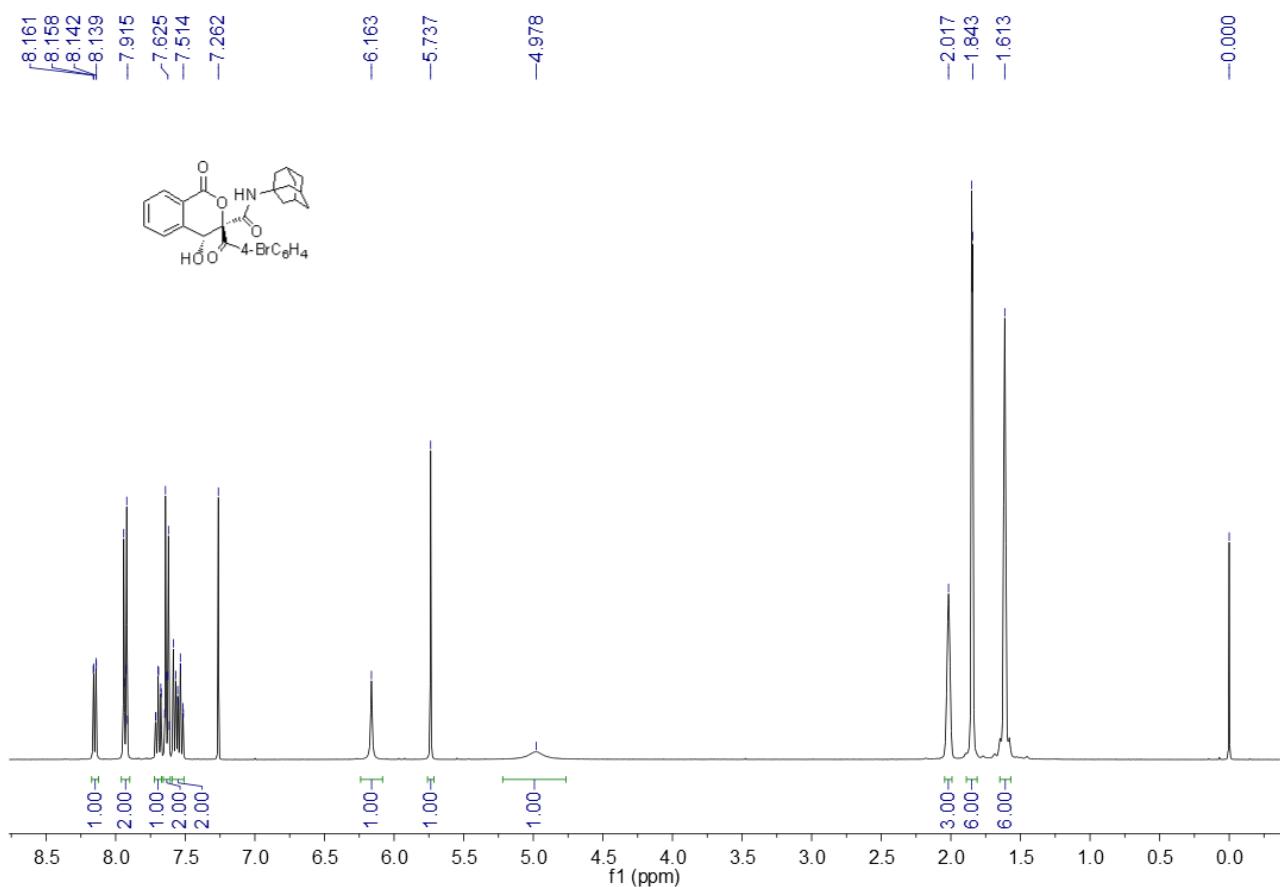


## **<sup>1</sup>H NMR Spectrum of Compound 4f**

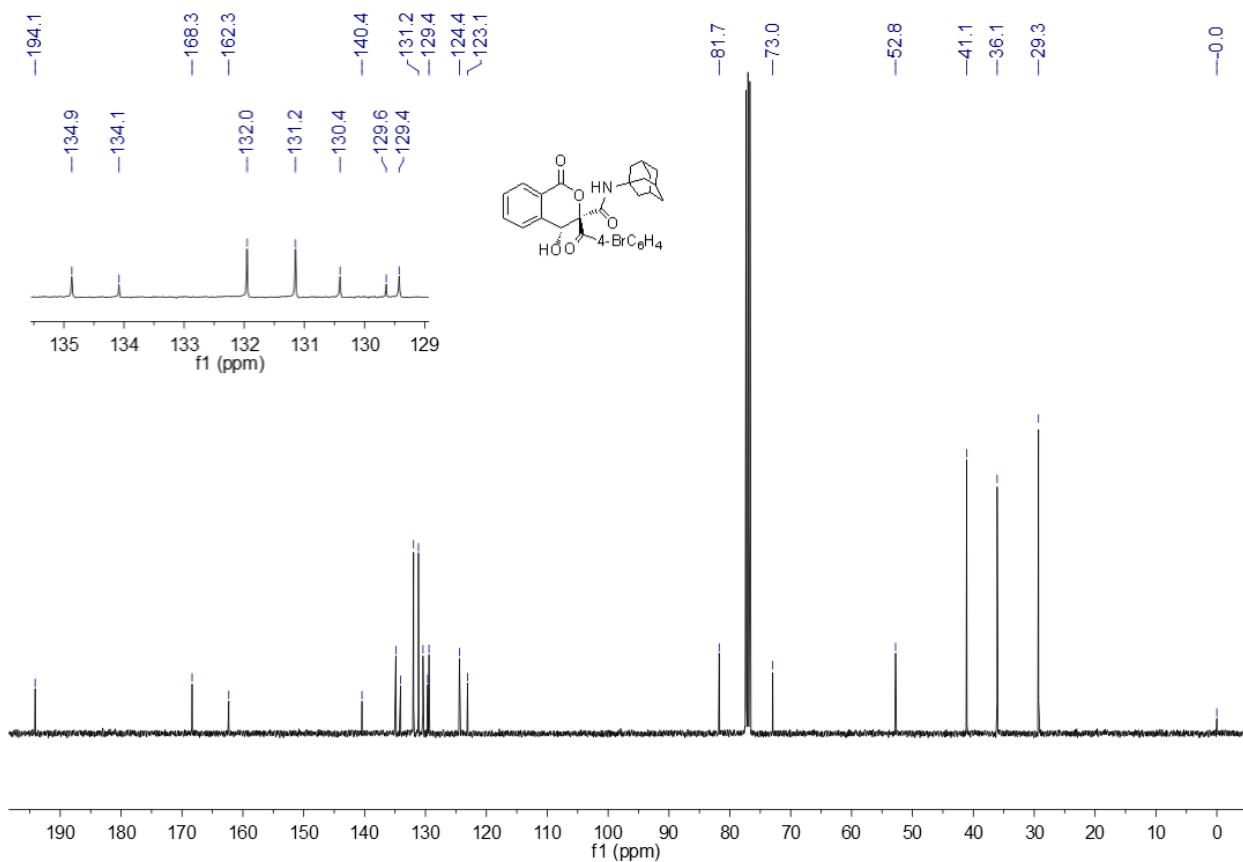


### **<sup>13</sup>C NMR Spectrum of Compound 4f**

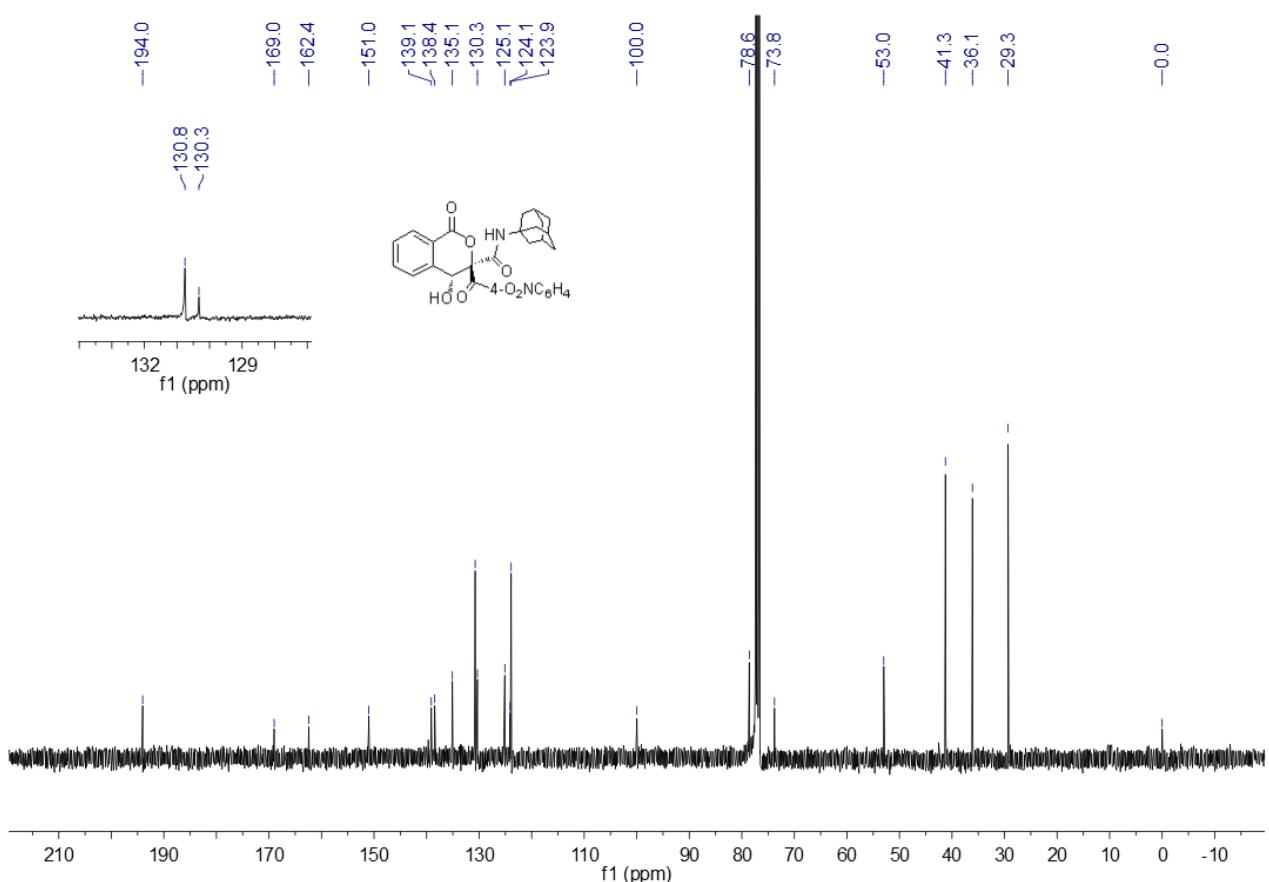
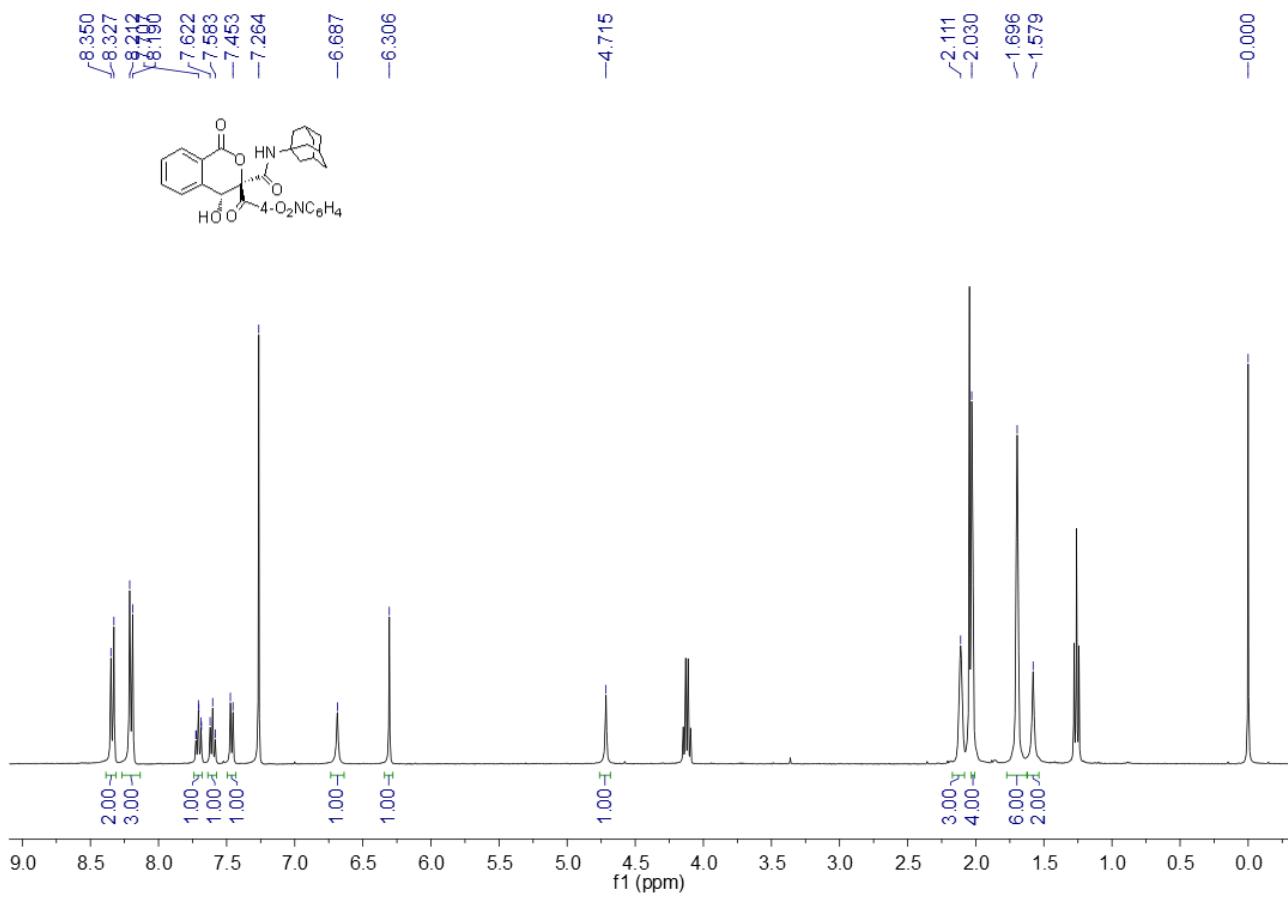


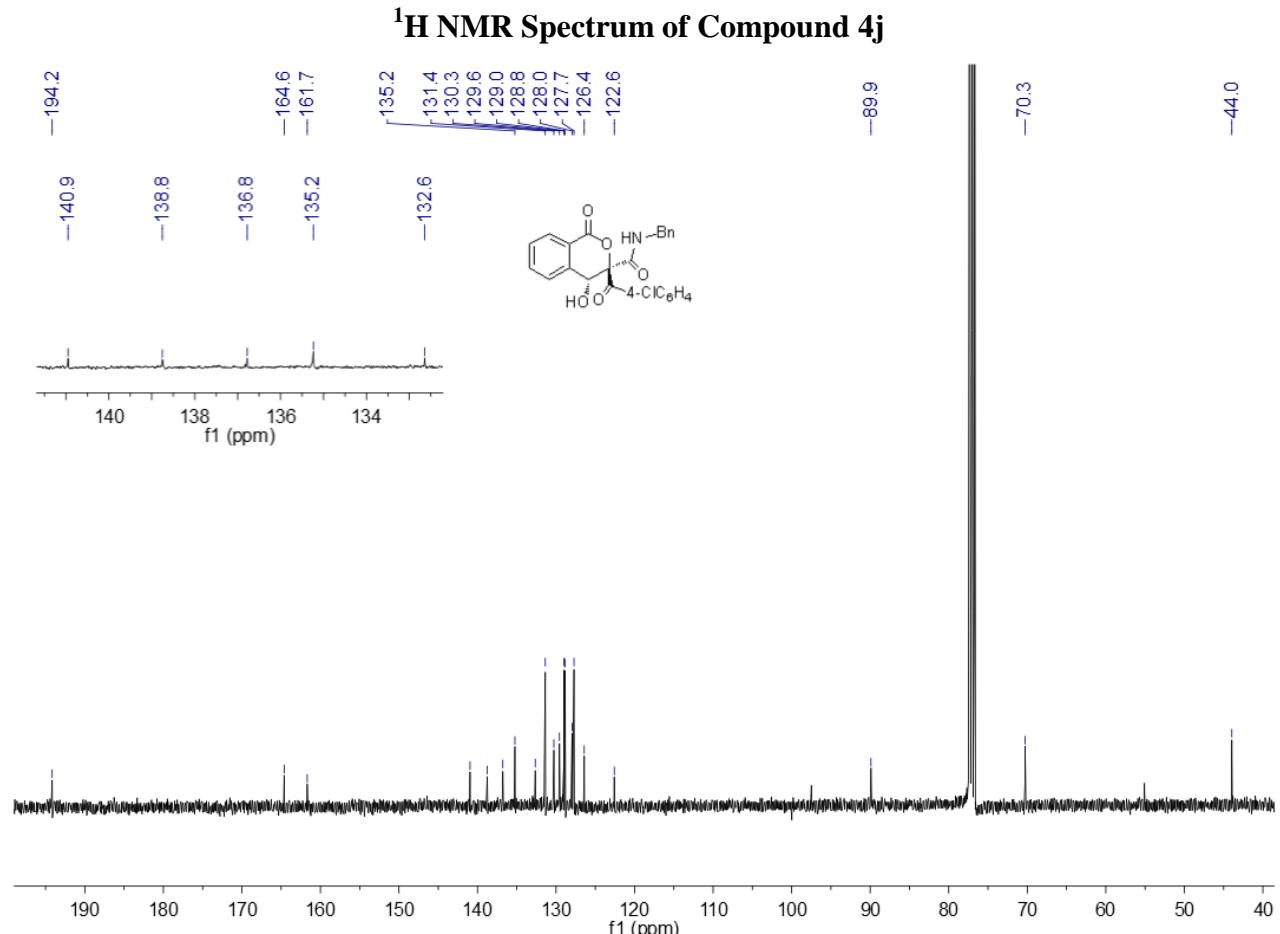
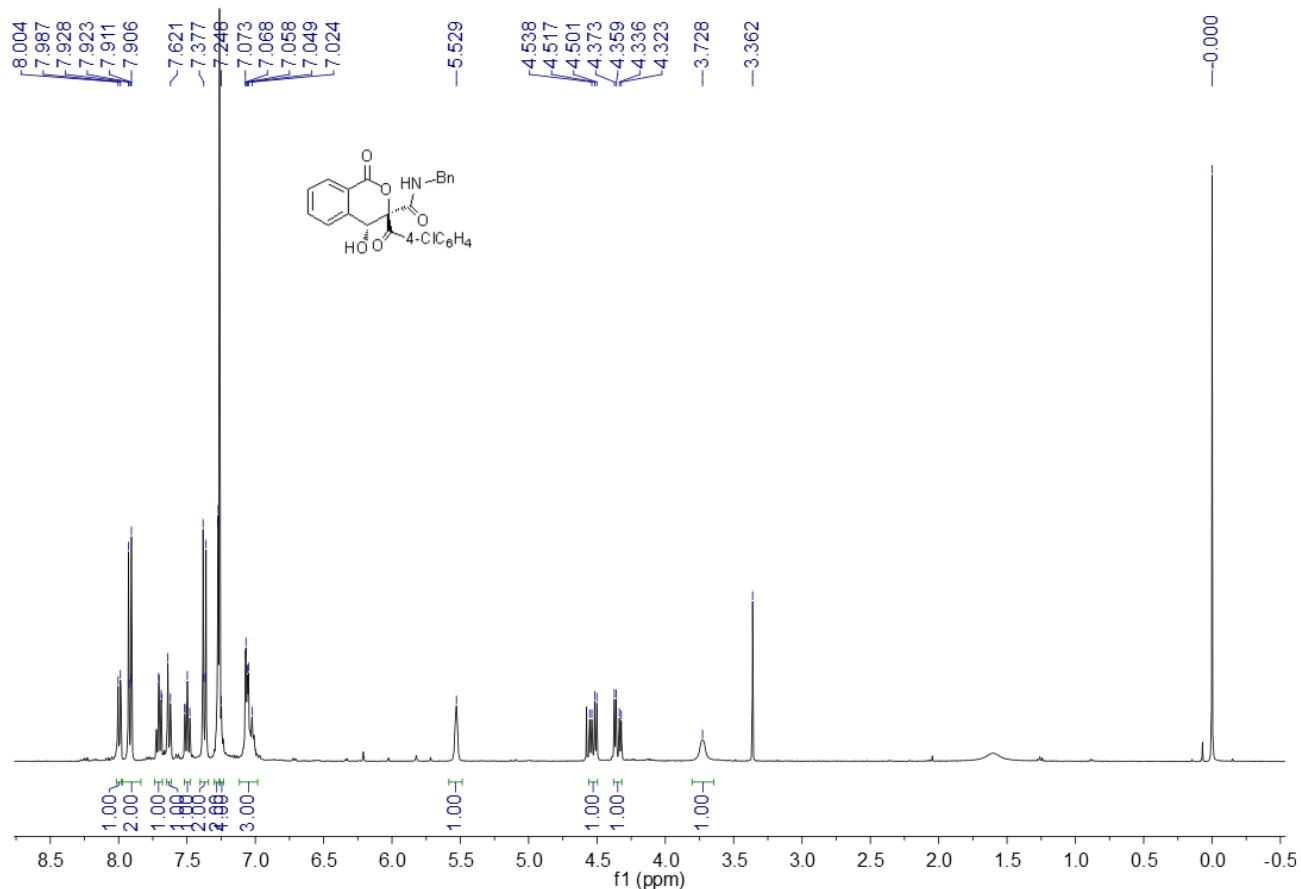


**<sup>1</sup>H NMR Spectrum of Compound 4h**

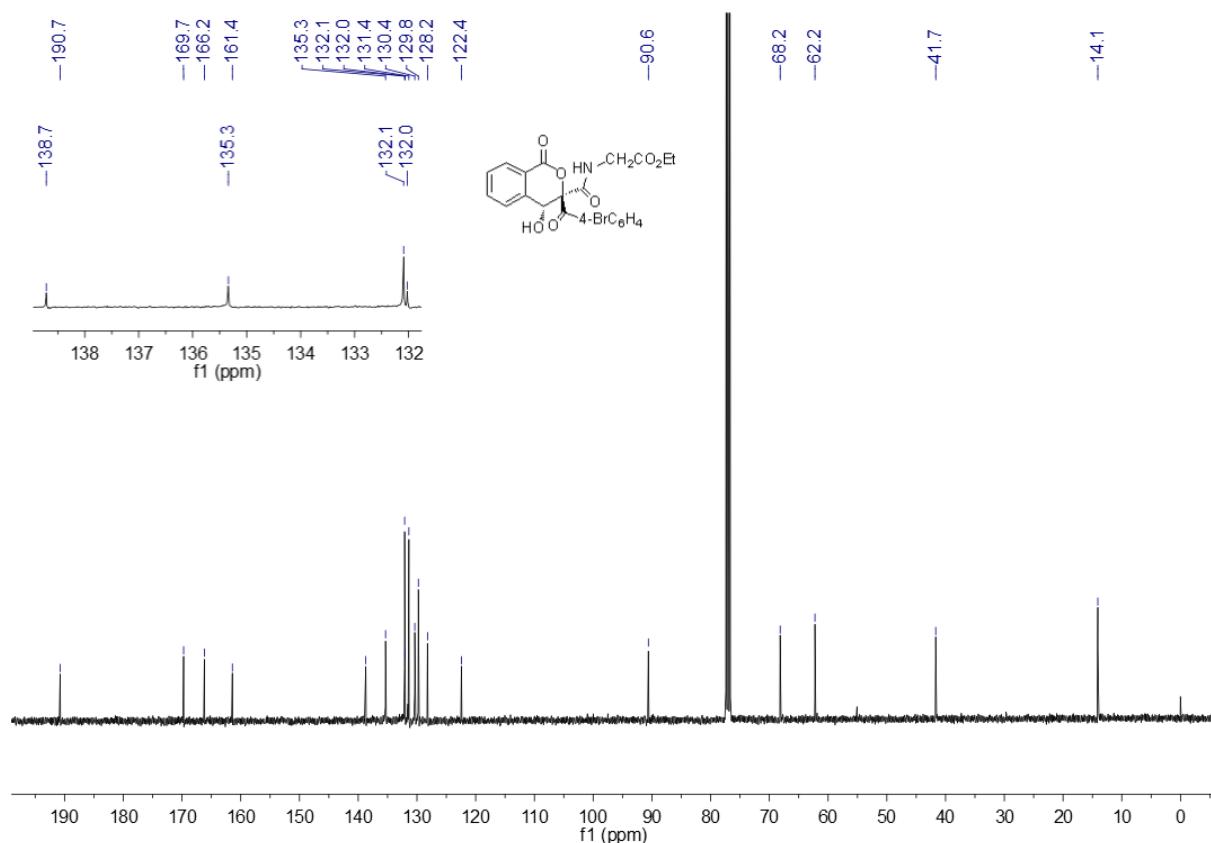
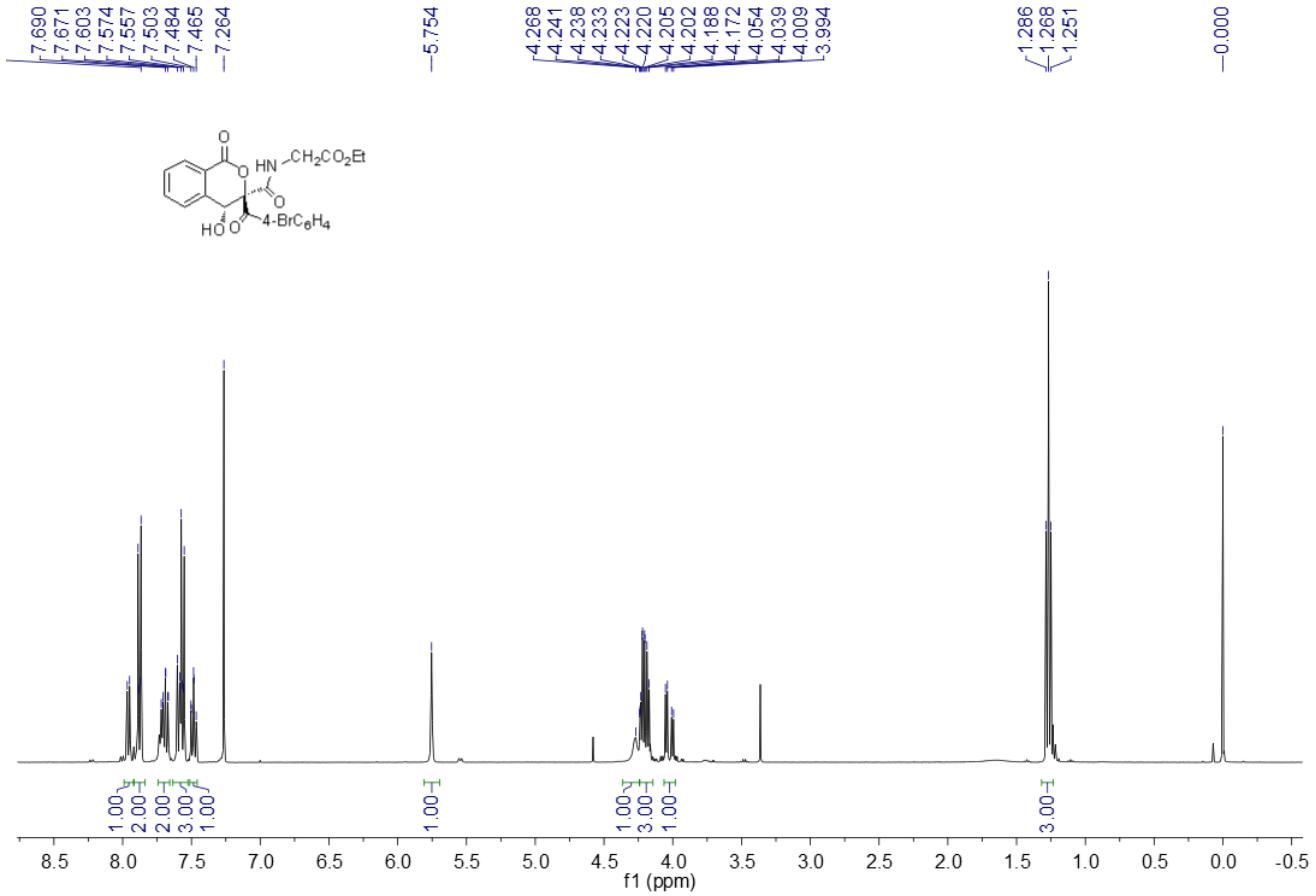


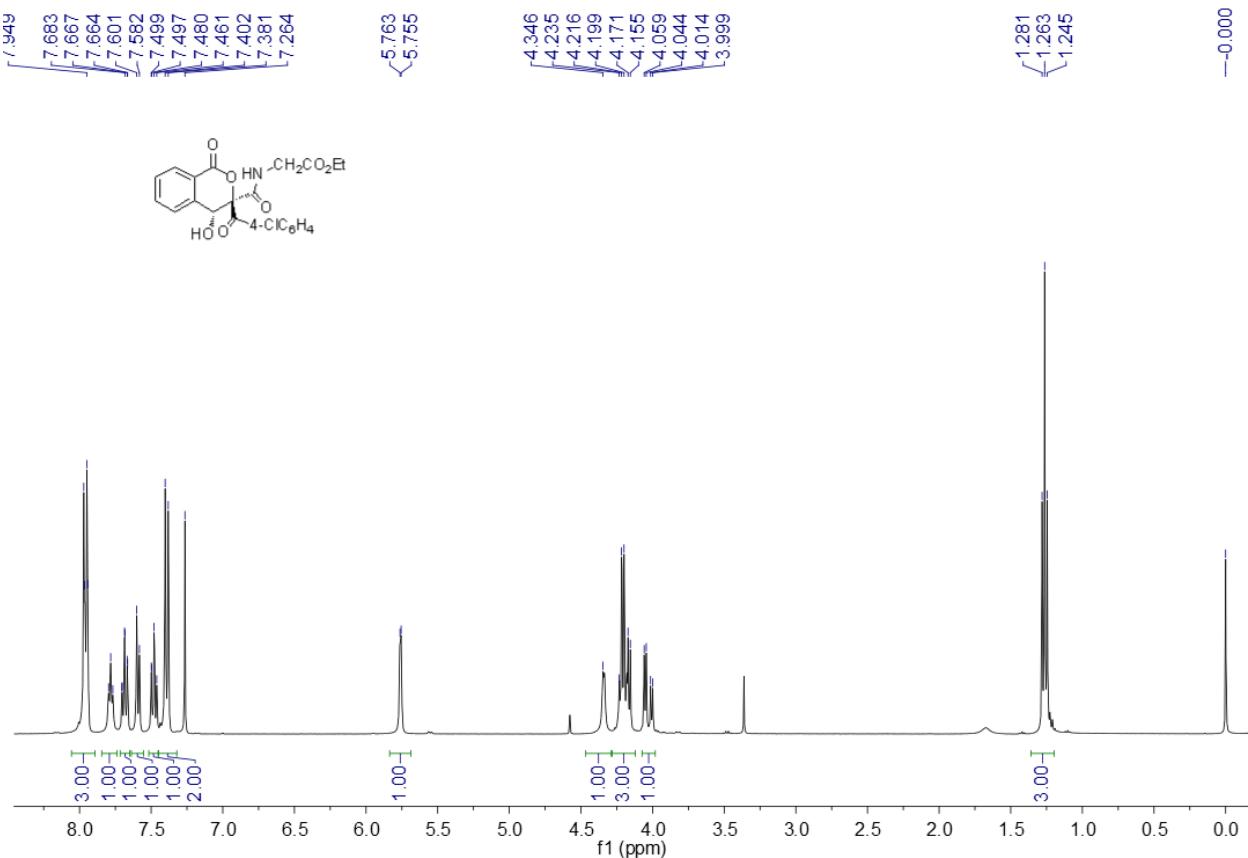
**<sup>13</sup>C NMR Spectrum of Compound 4h**



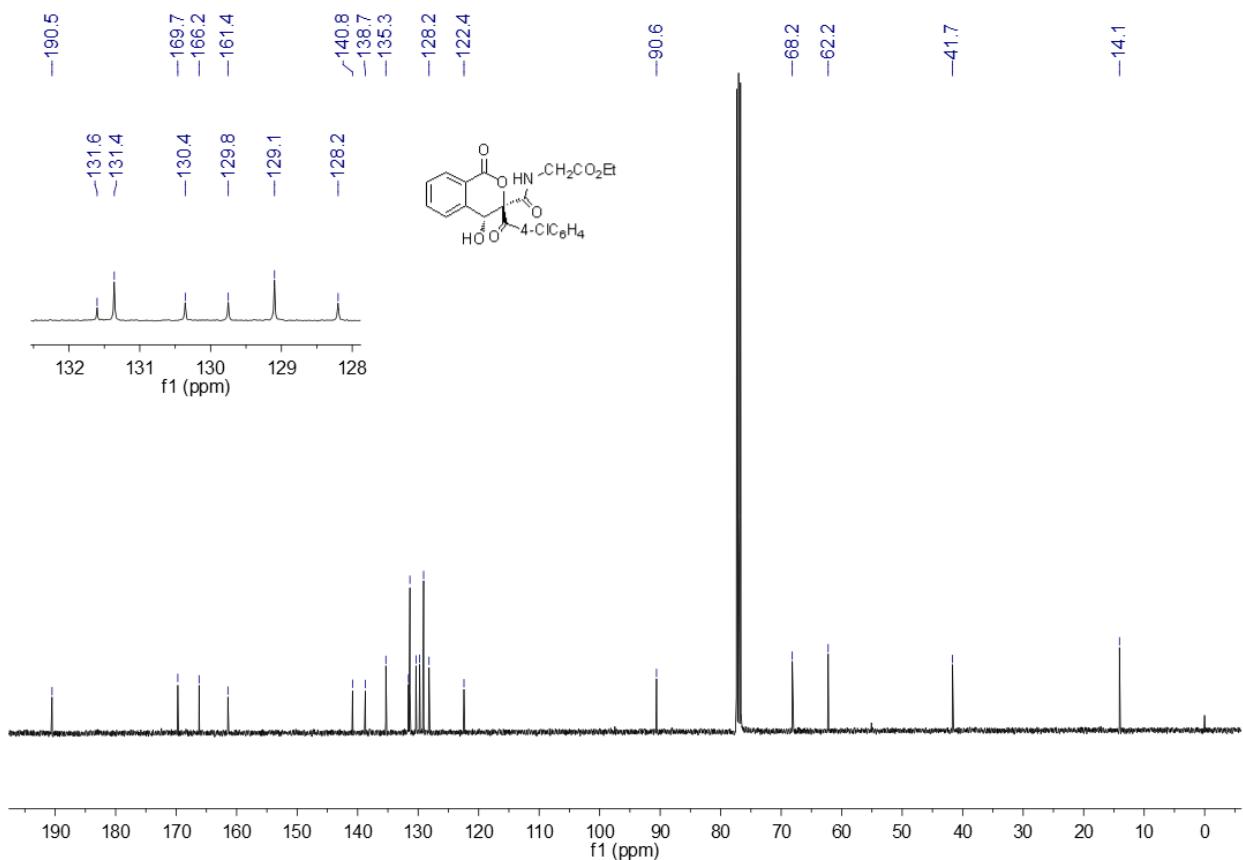


<sup>13</sup>C NMR Spectrum of Compound 4j

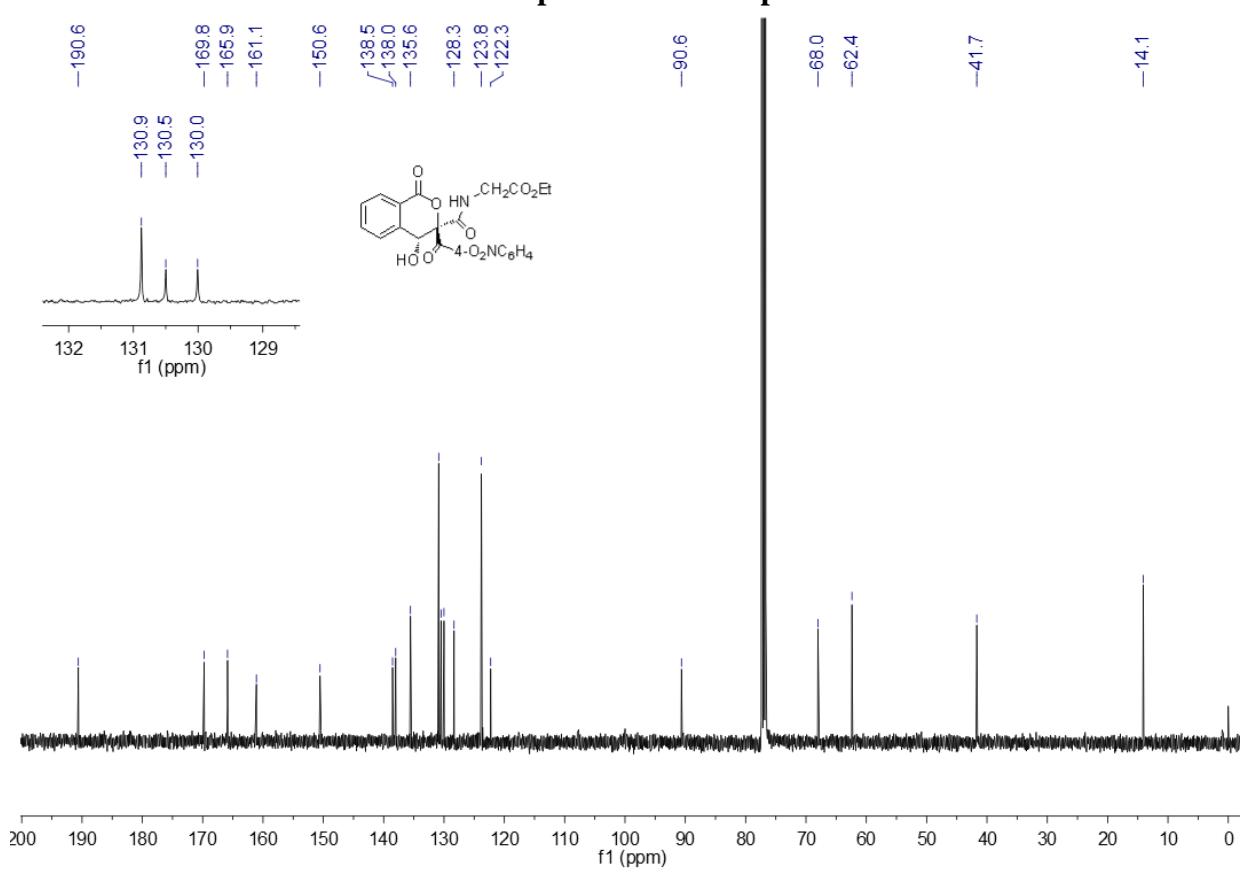
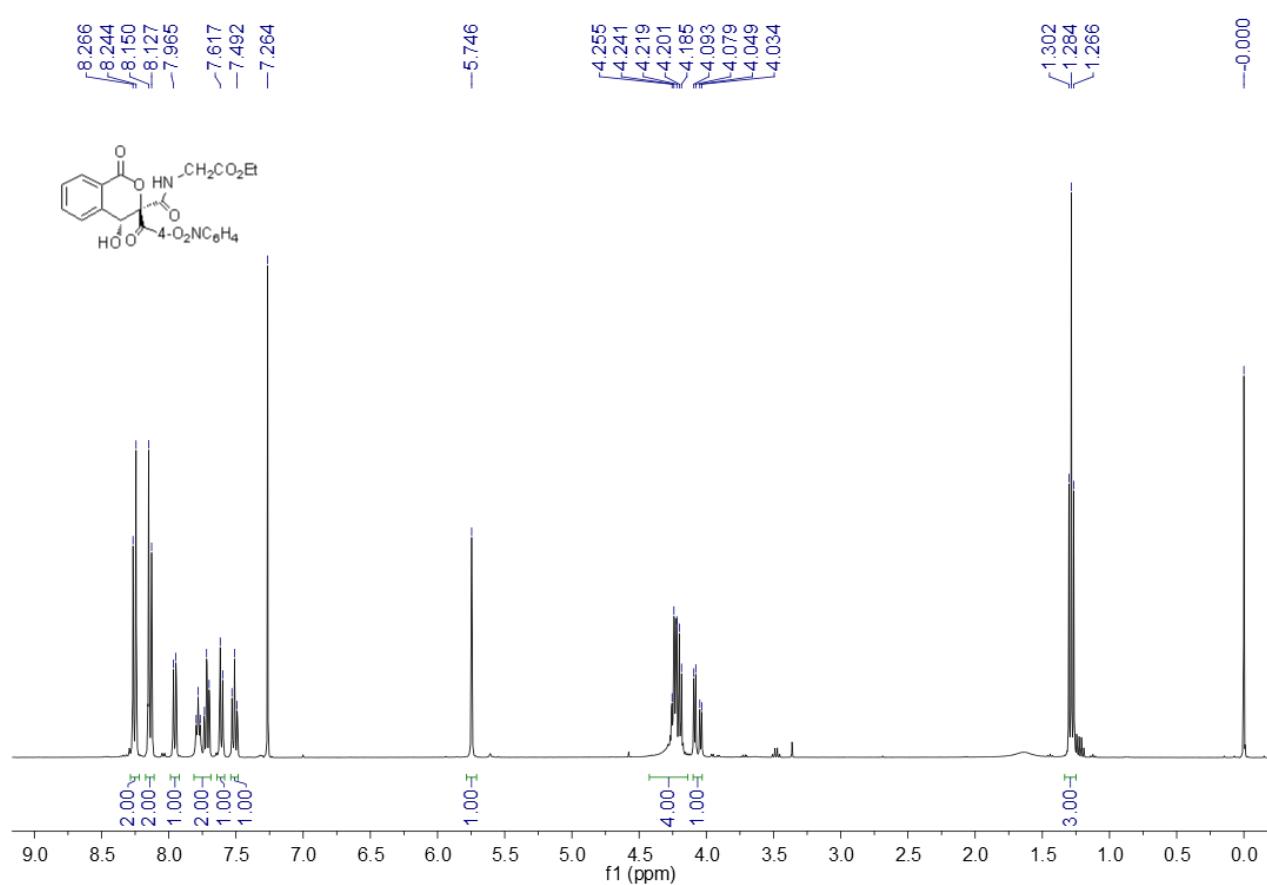


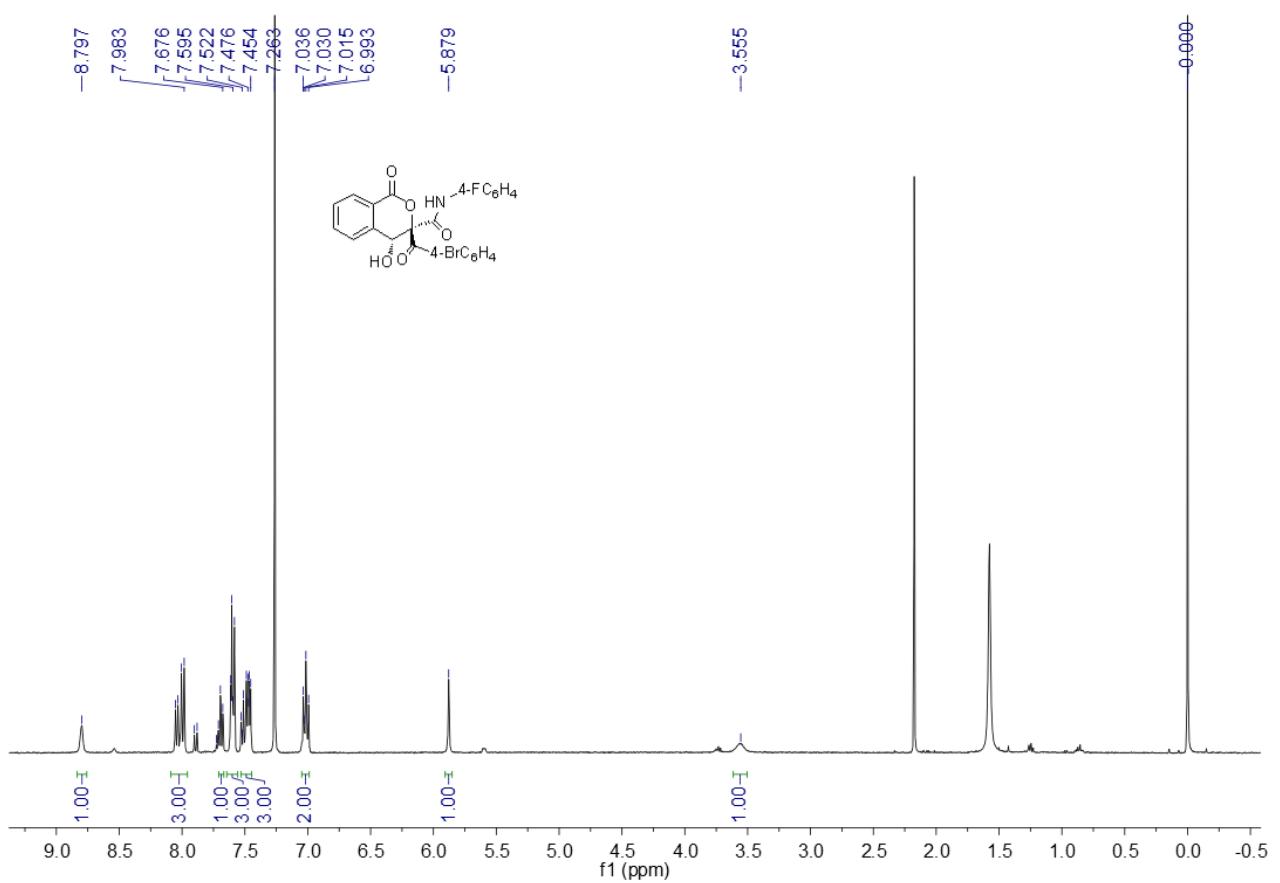


## **<sup>1</sup>H NMR Spectrum of Compound 4l**

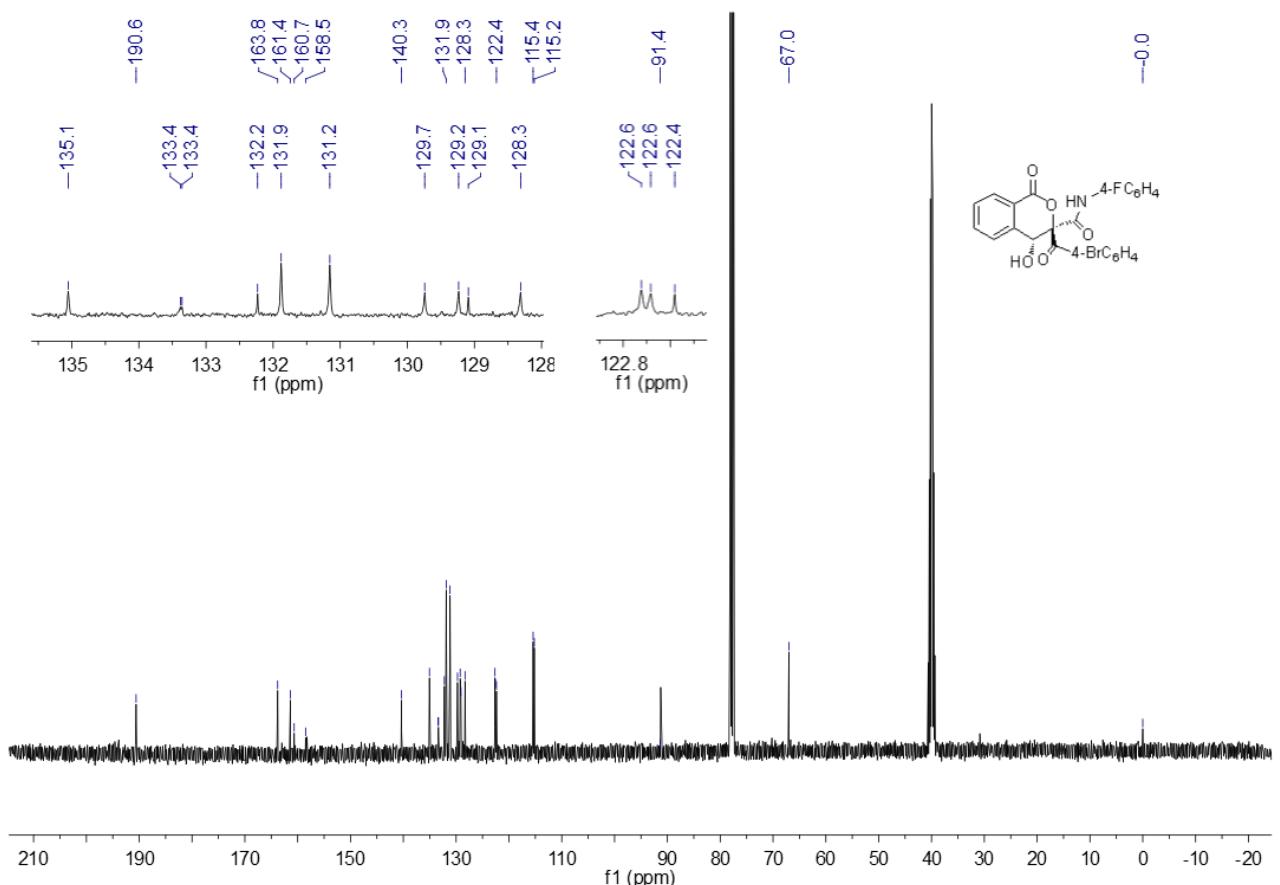


### **<sup>13</sup>C NMR Spectrum of Compound 4l**

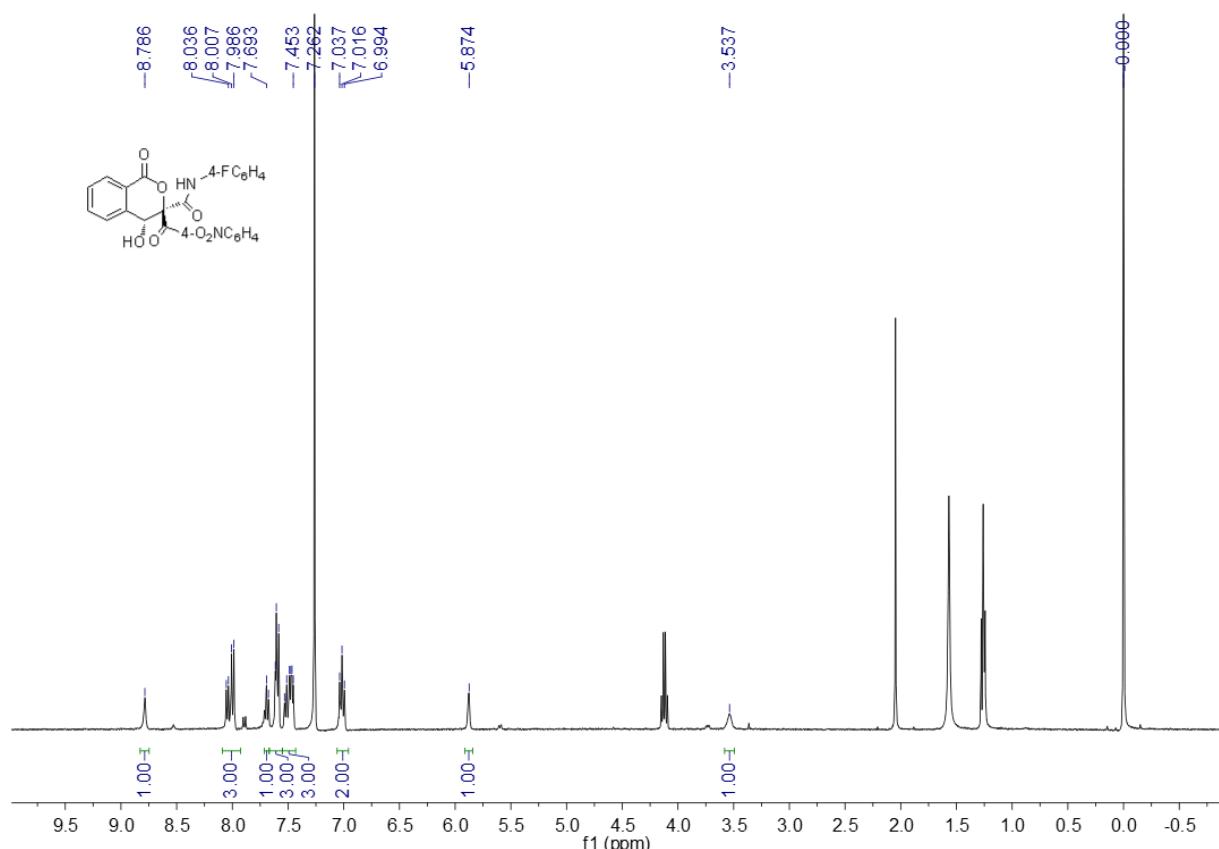




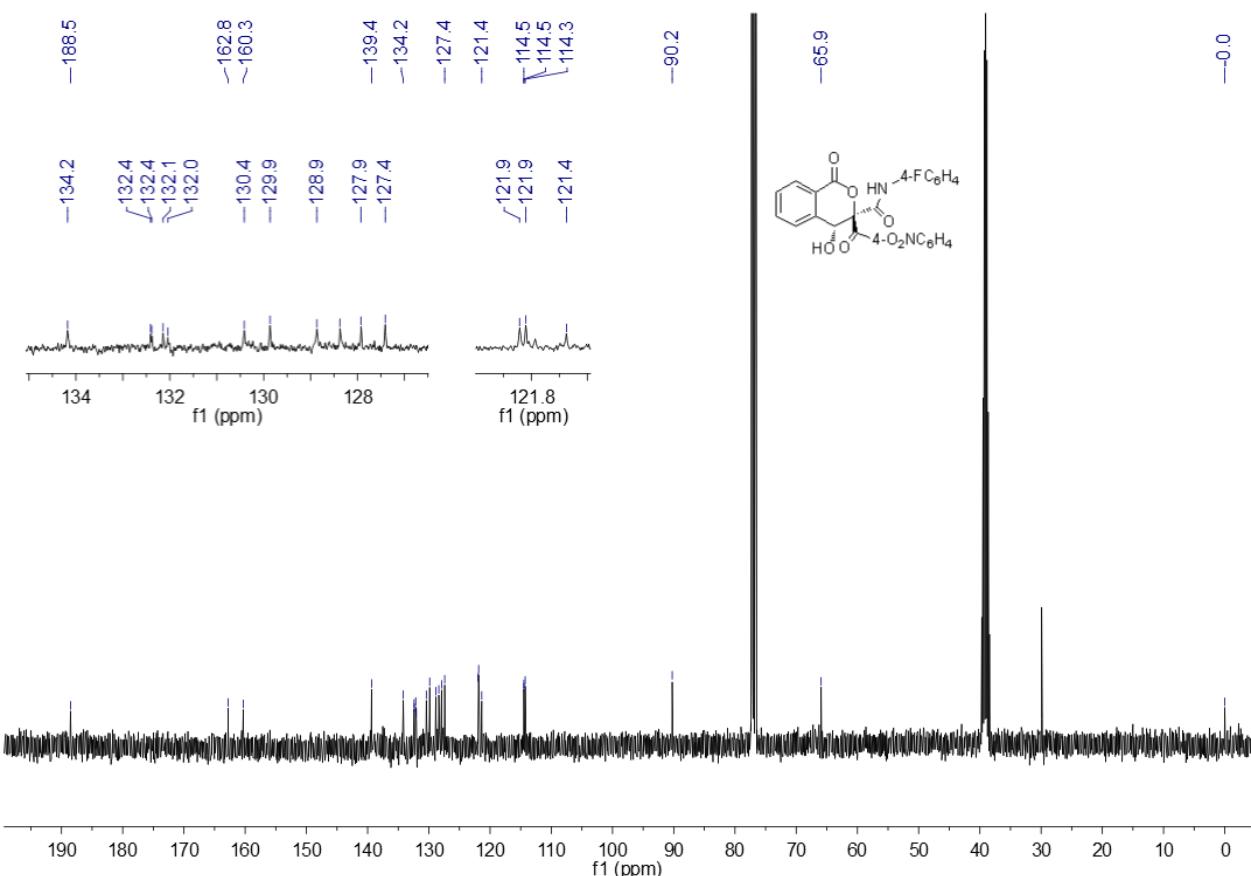
<sup>1</sup>H NMR Spectrum of Compound 4n



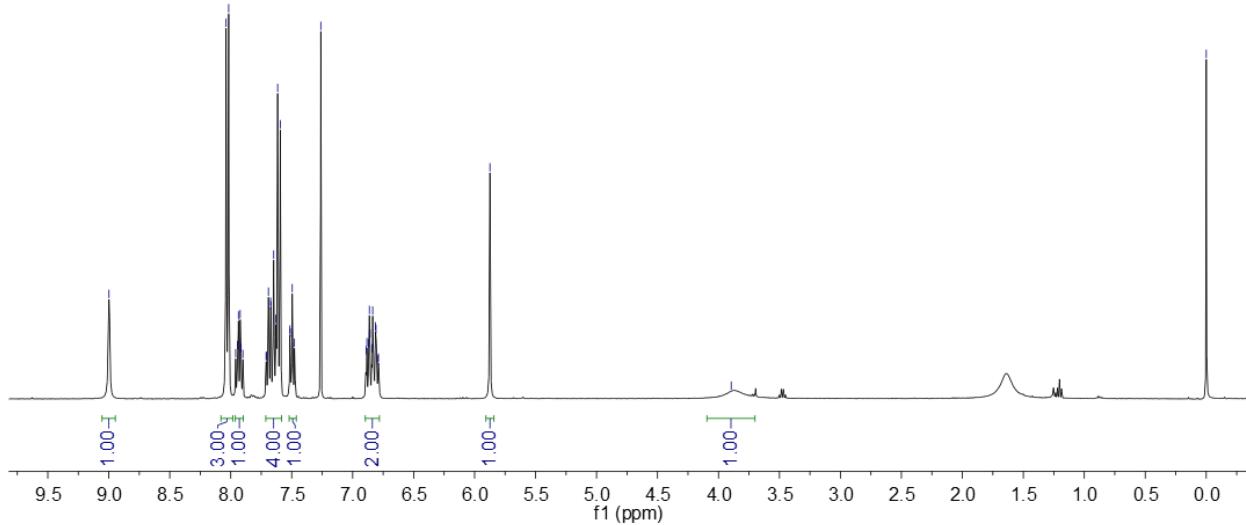
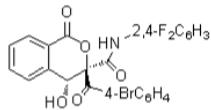
<sup>13</sup>C NMR Spectrum of Compound 4n



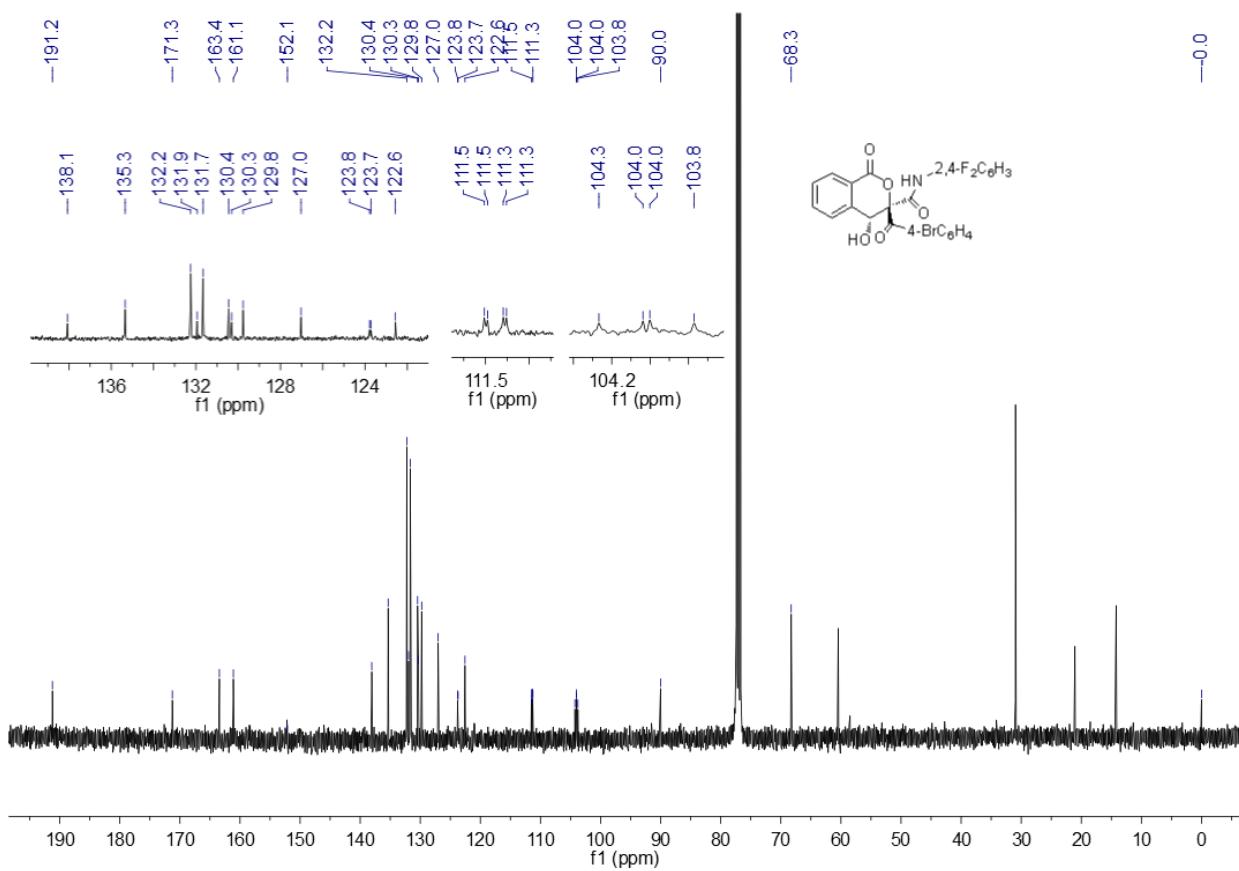
## **<sup>1</sup>H NMR Spectrum of Compound 4o**



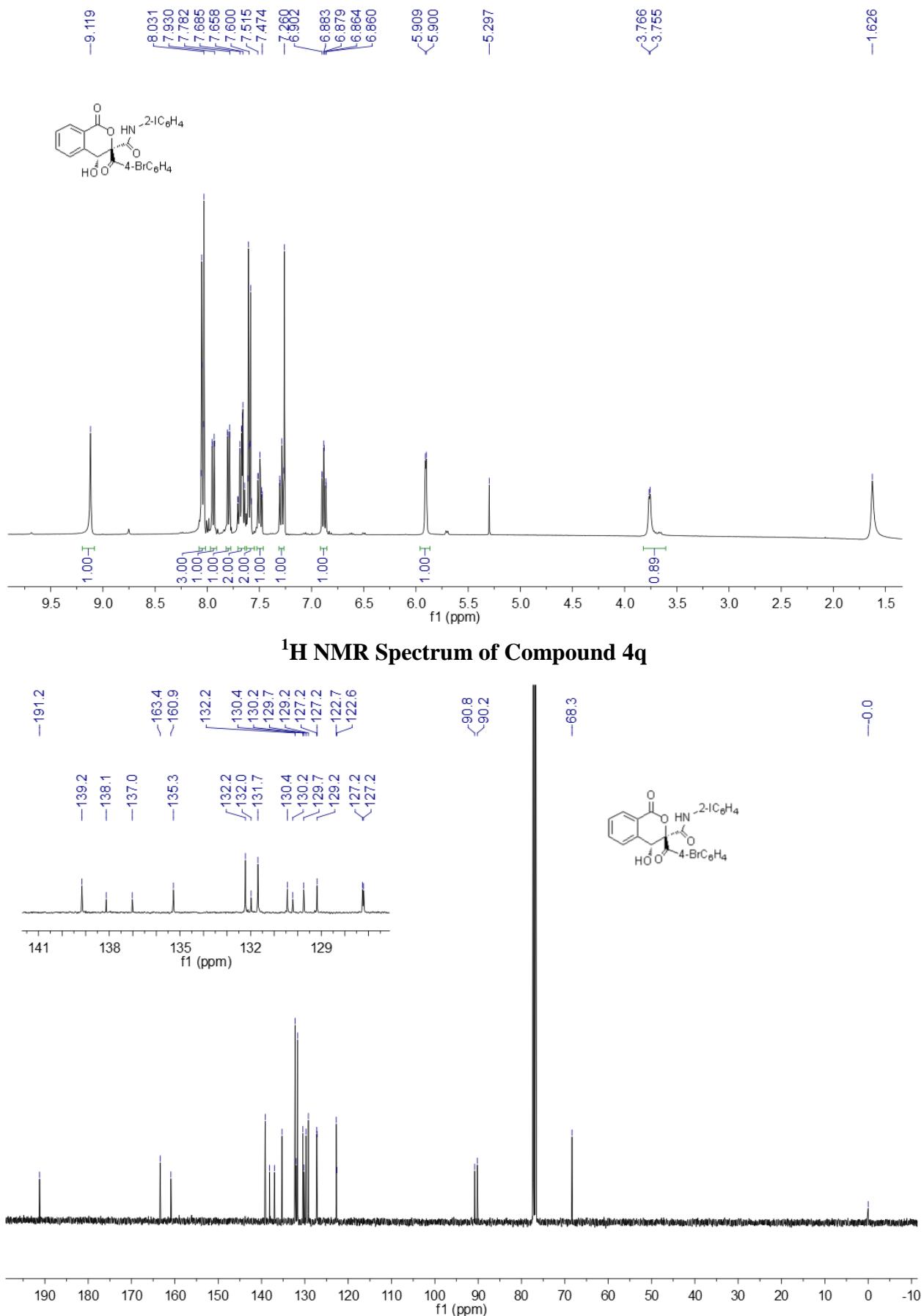
### **<sup>13</sup>C NMR Spectrum of Compound 4o**

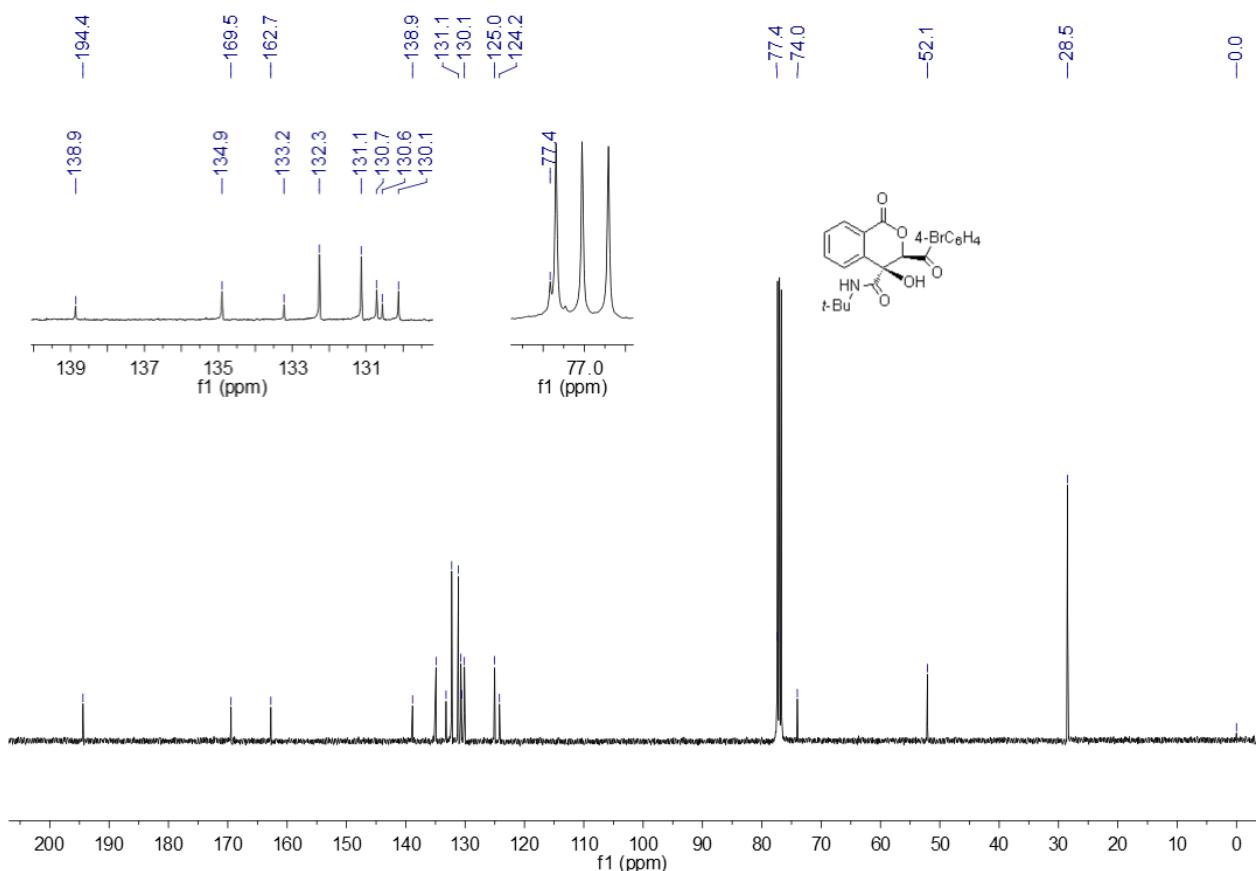
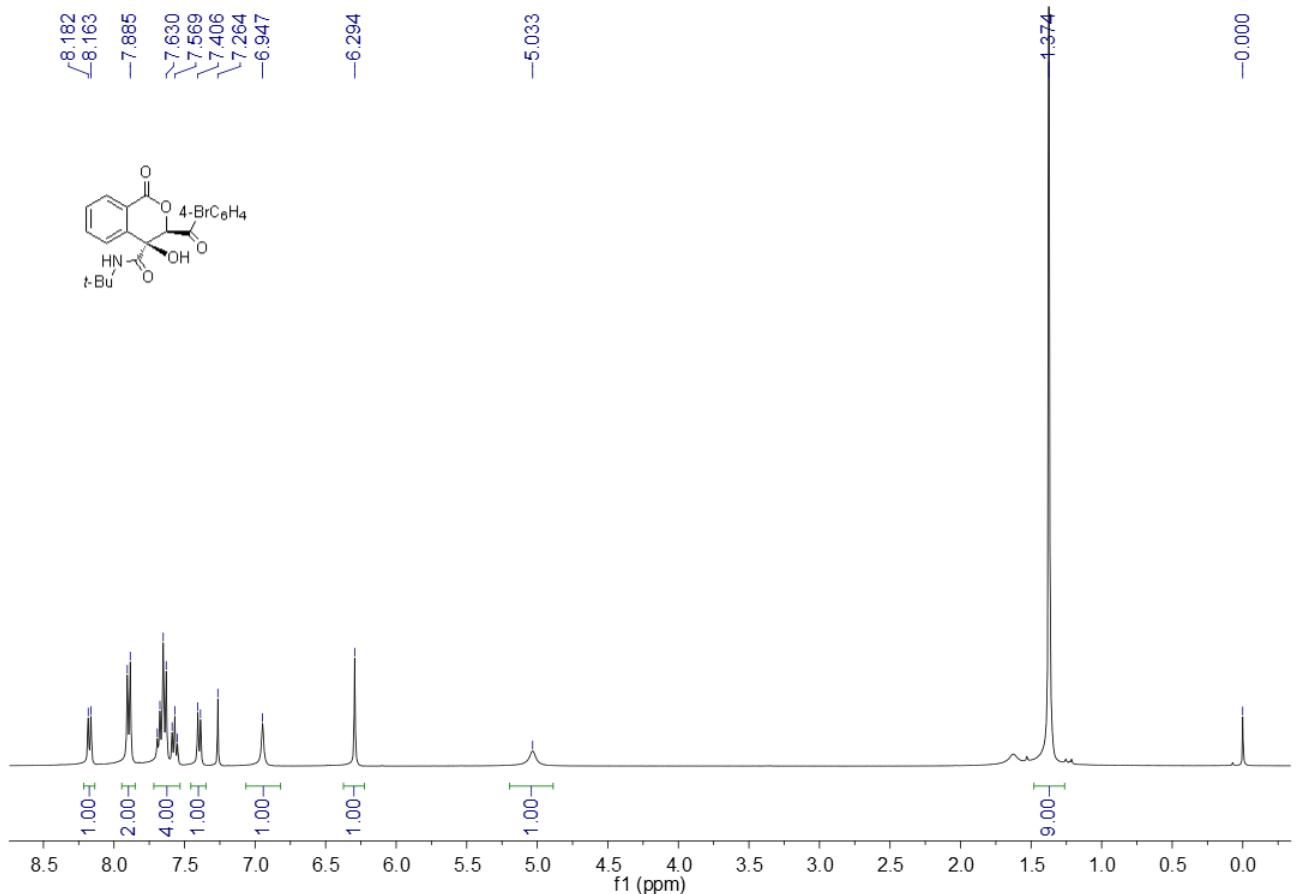


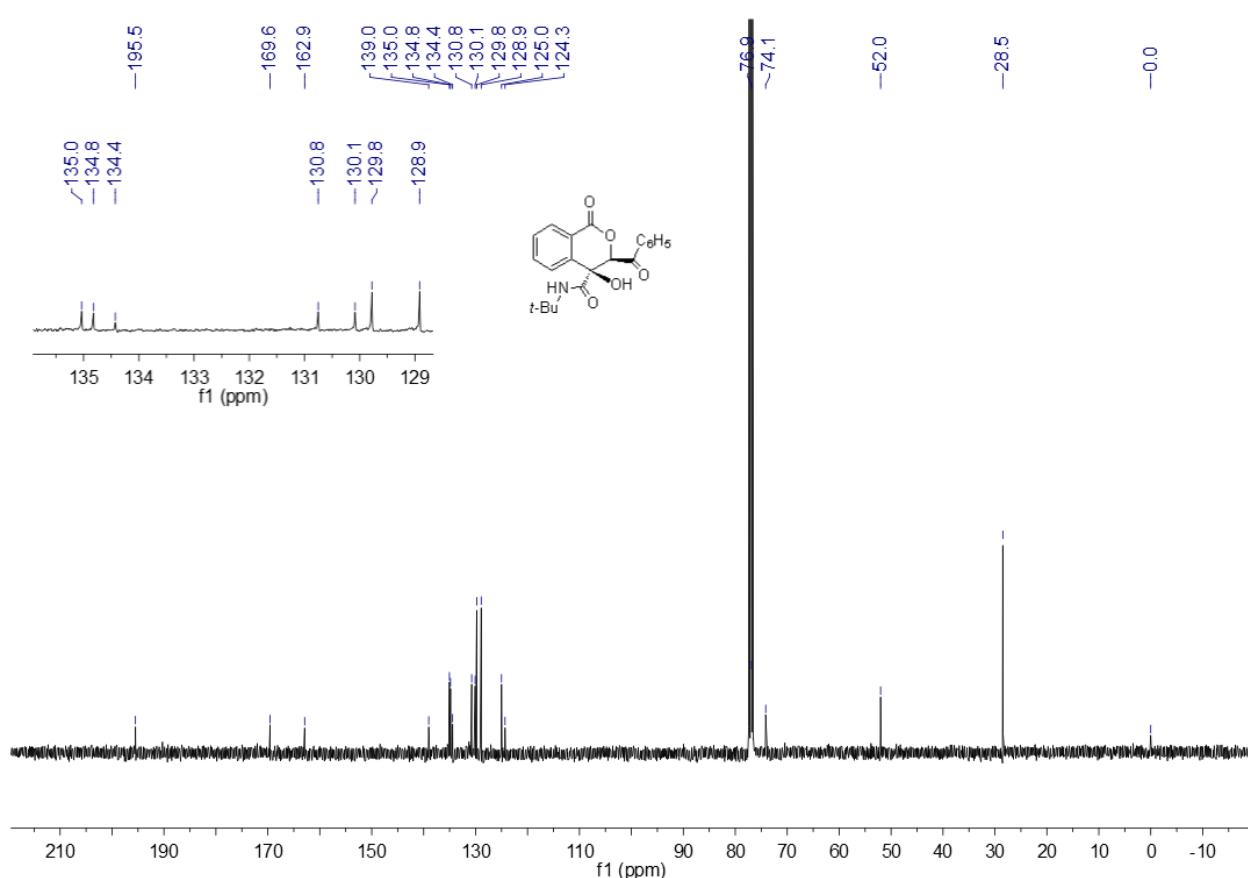
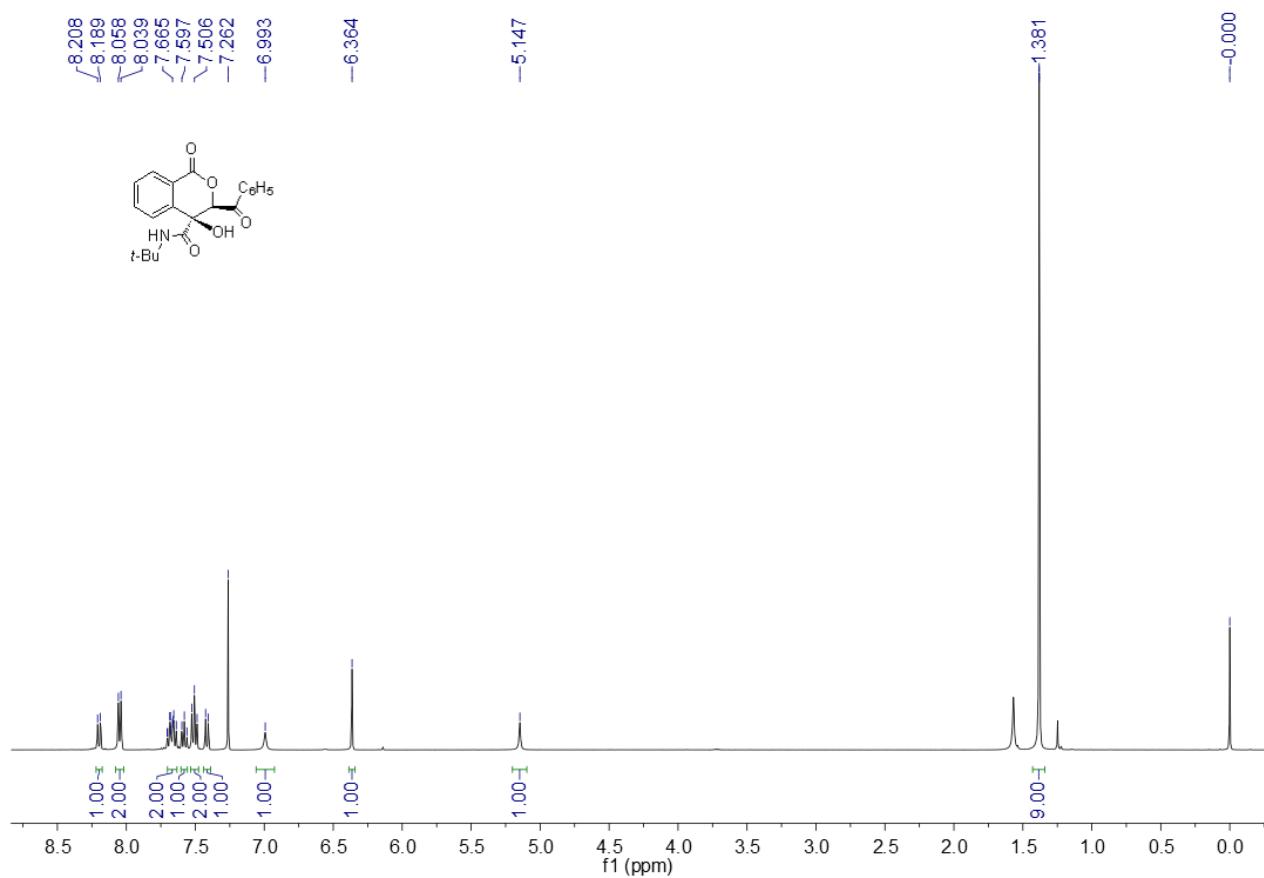
## **<sup>1</sup>H NMR Spectrum of Compound 4p**

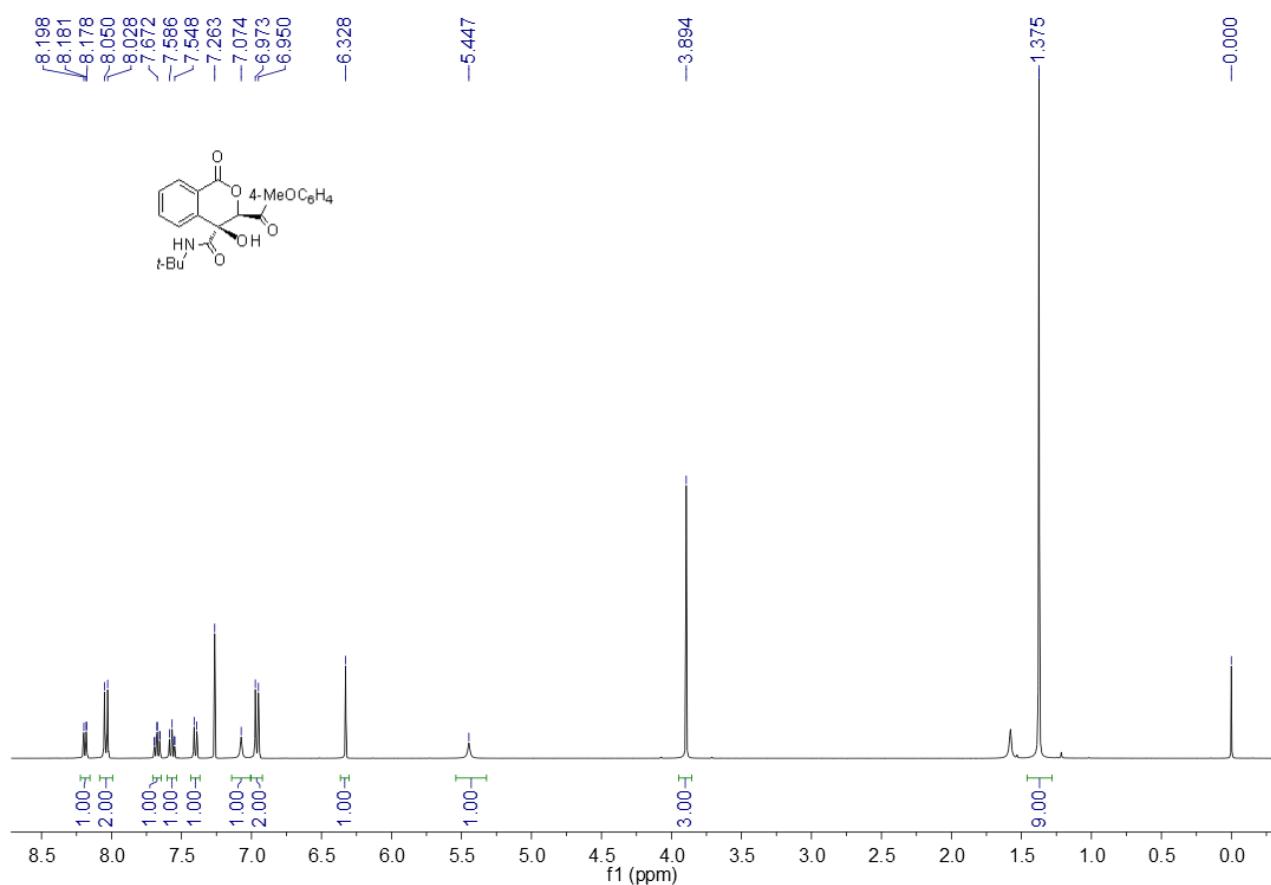


### **<sup>13</sup>C NMR Spectrum of Compound 4p**

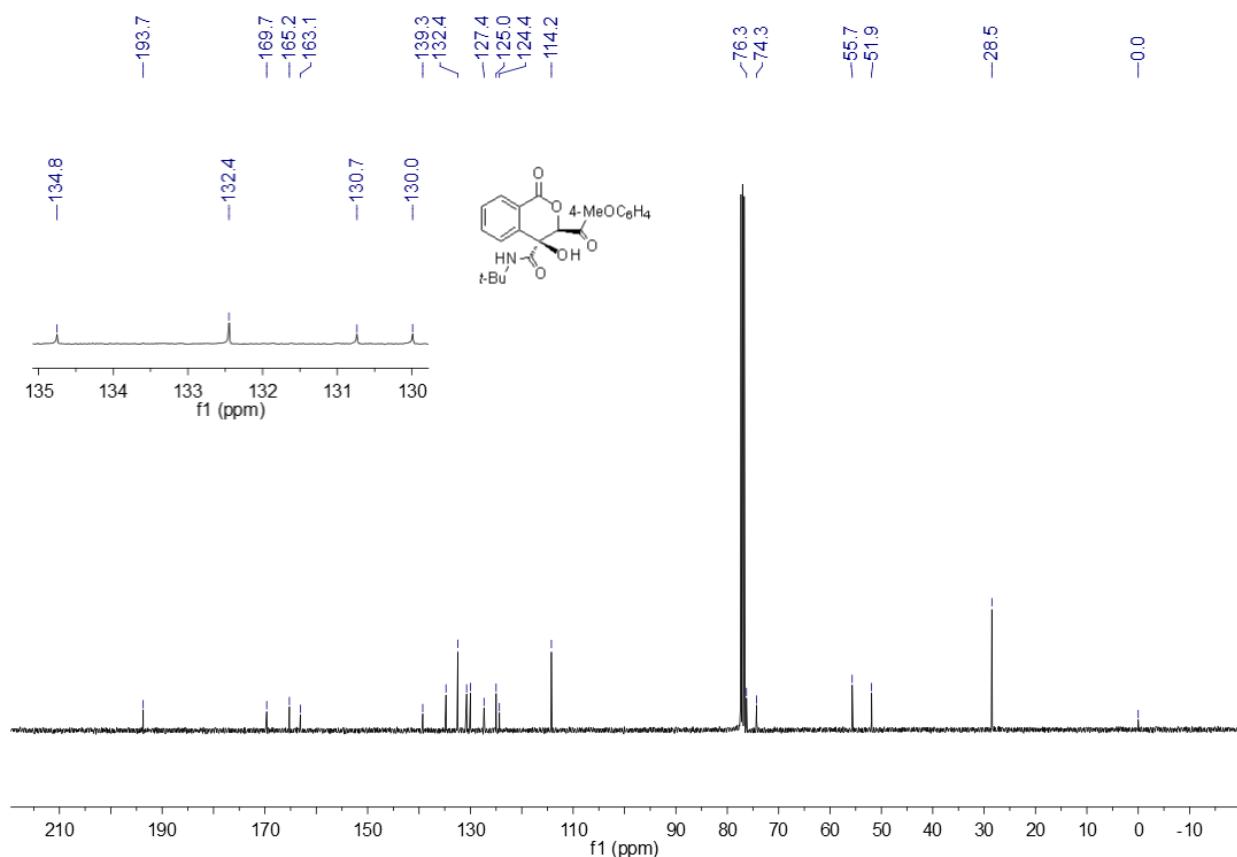




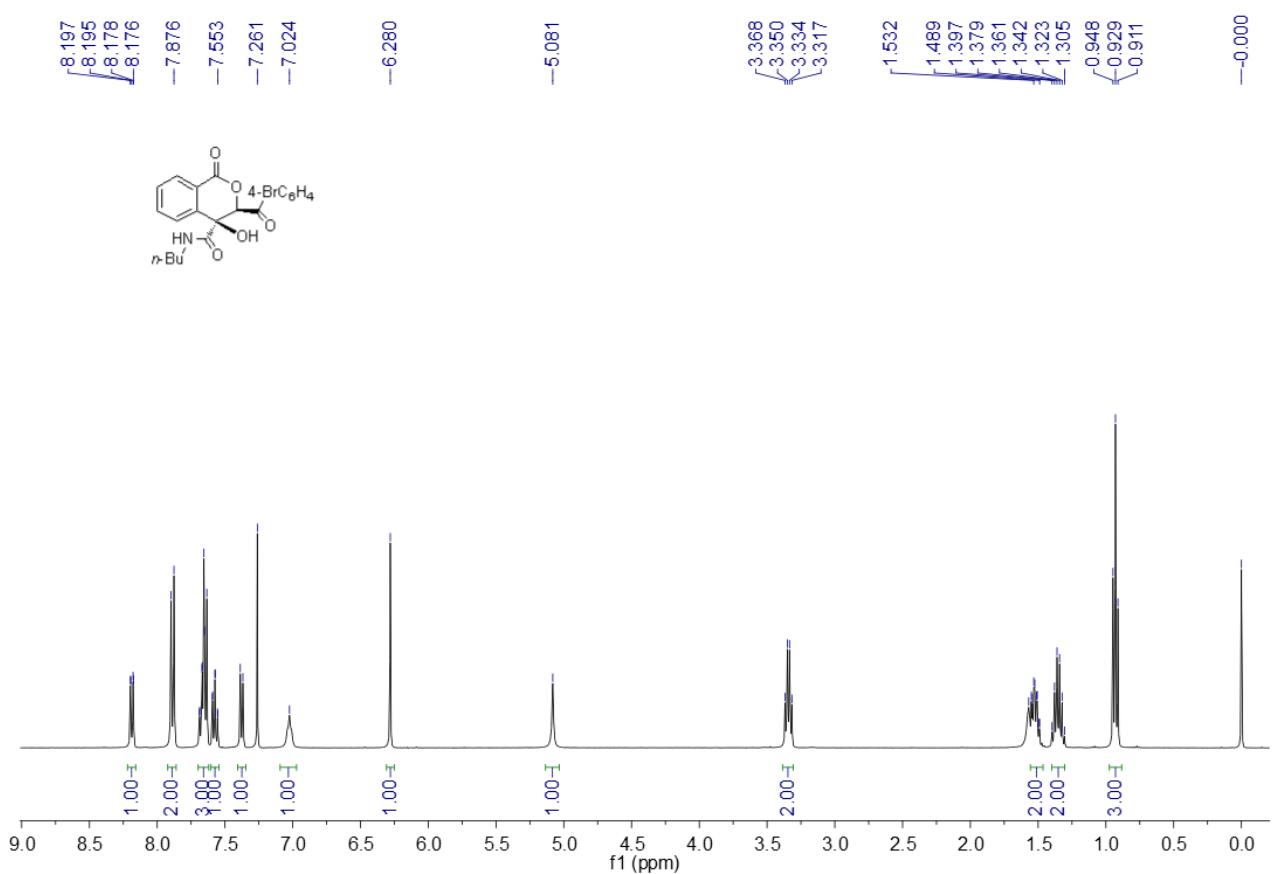




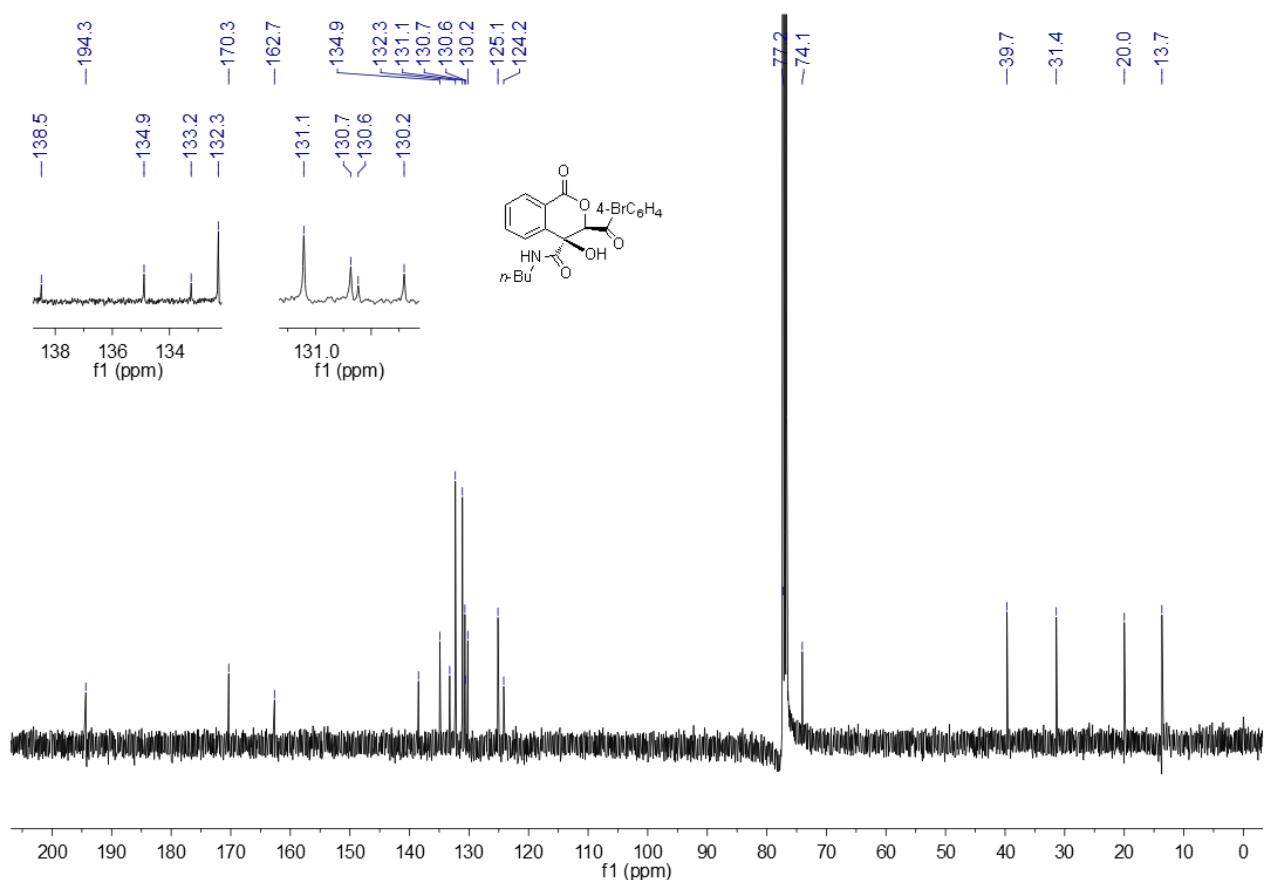
**<sup>1</sup>H NMR Spectrum of Compound 5c**



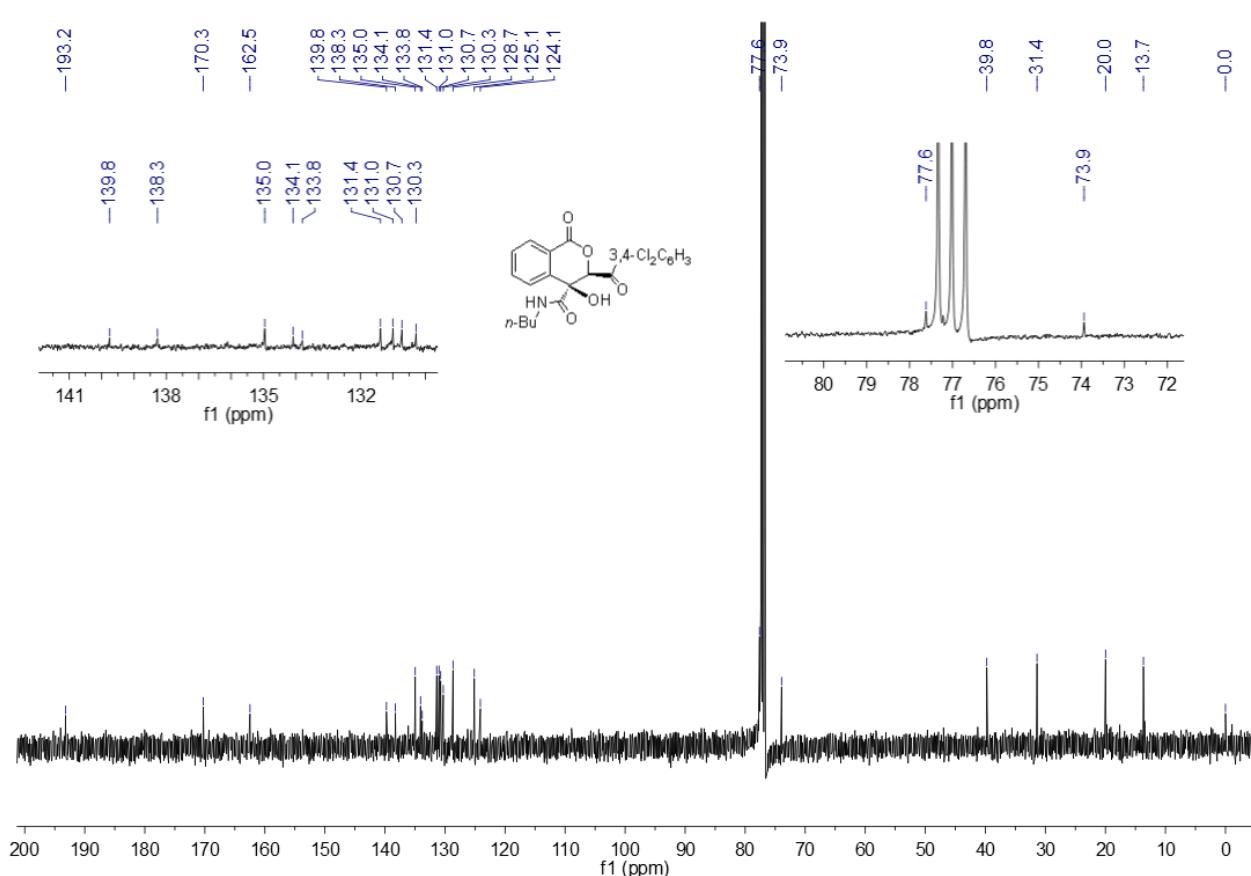
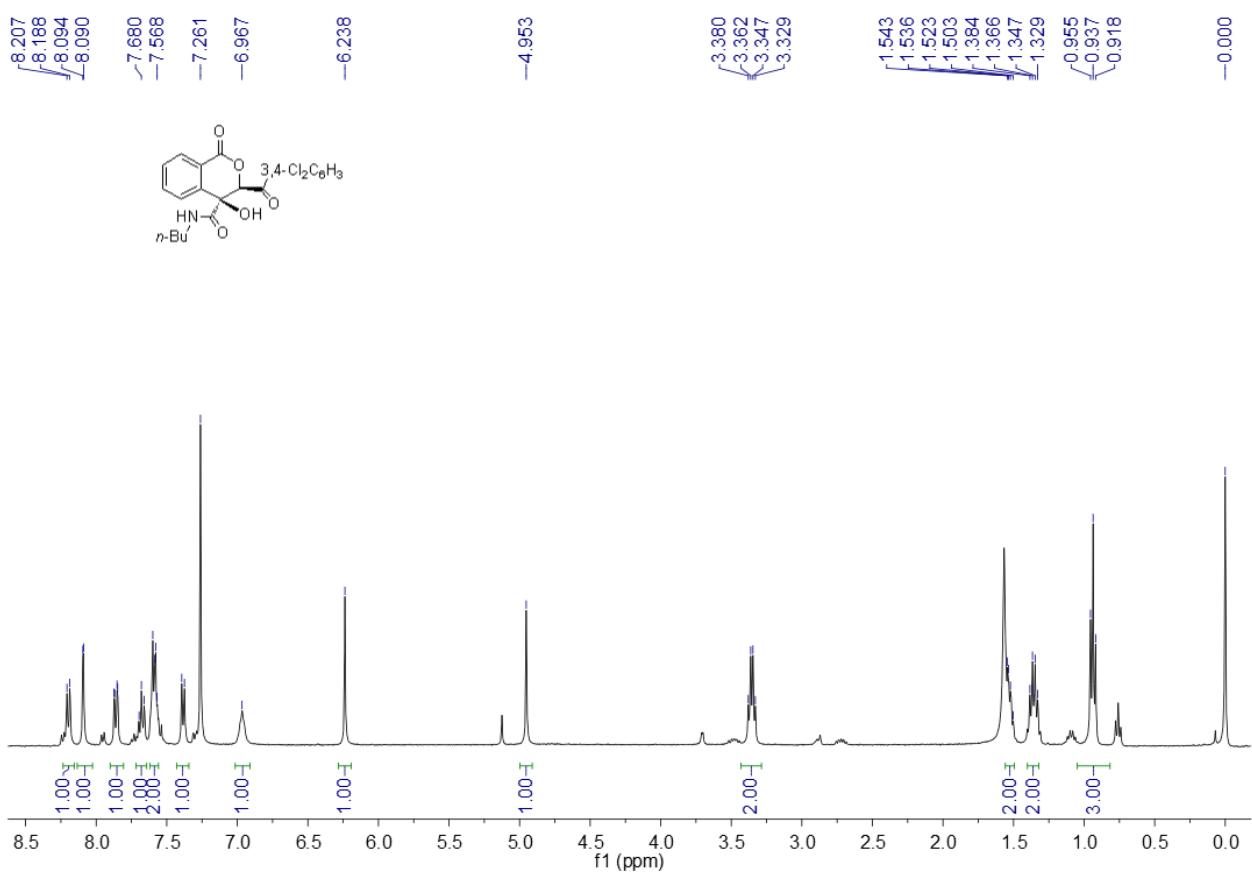
**<sup>13</sup>C NMR Spectrum of Compound 5c**

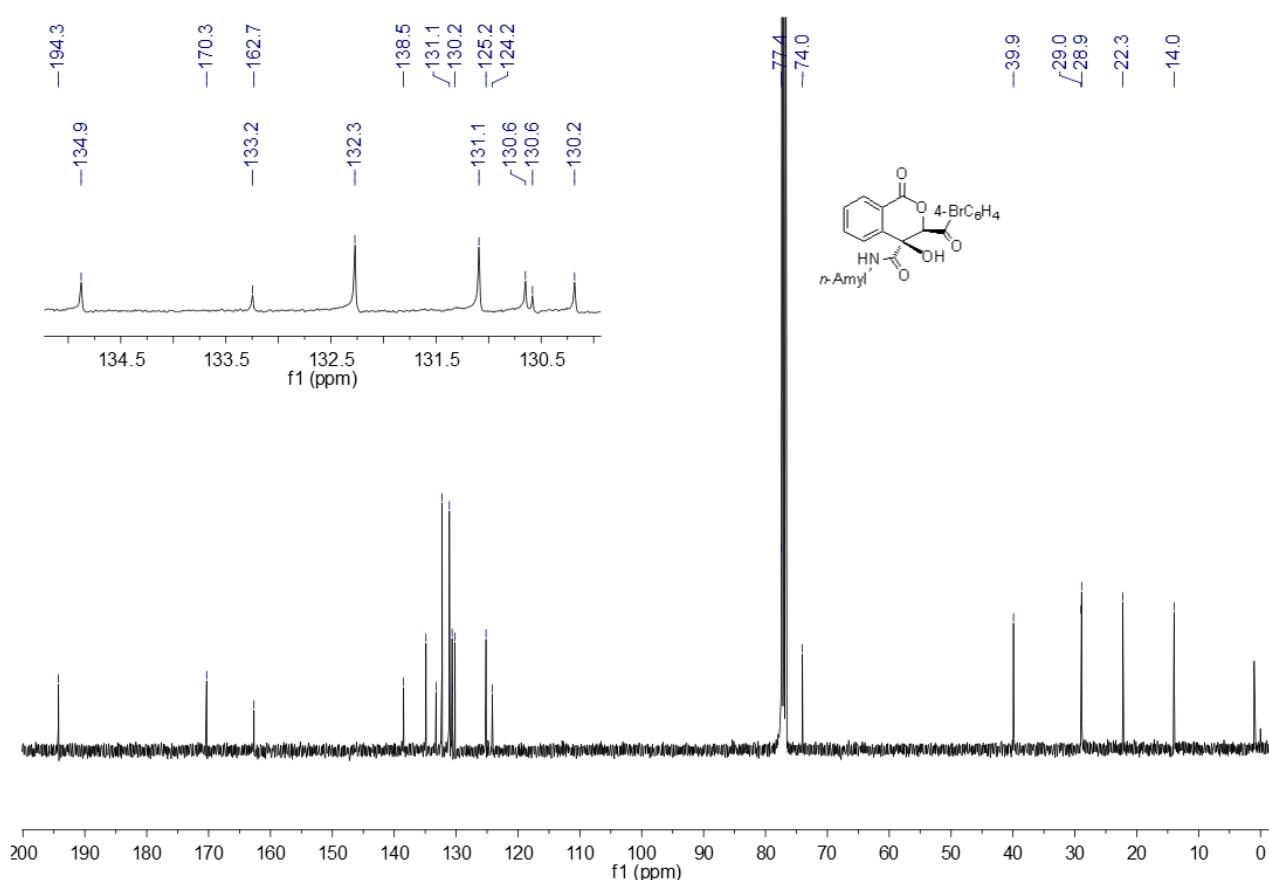
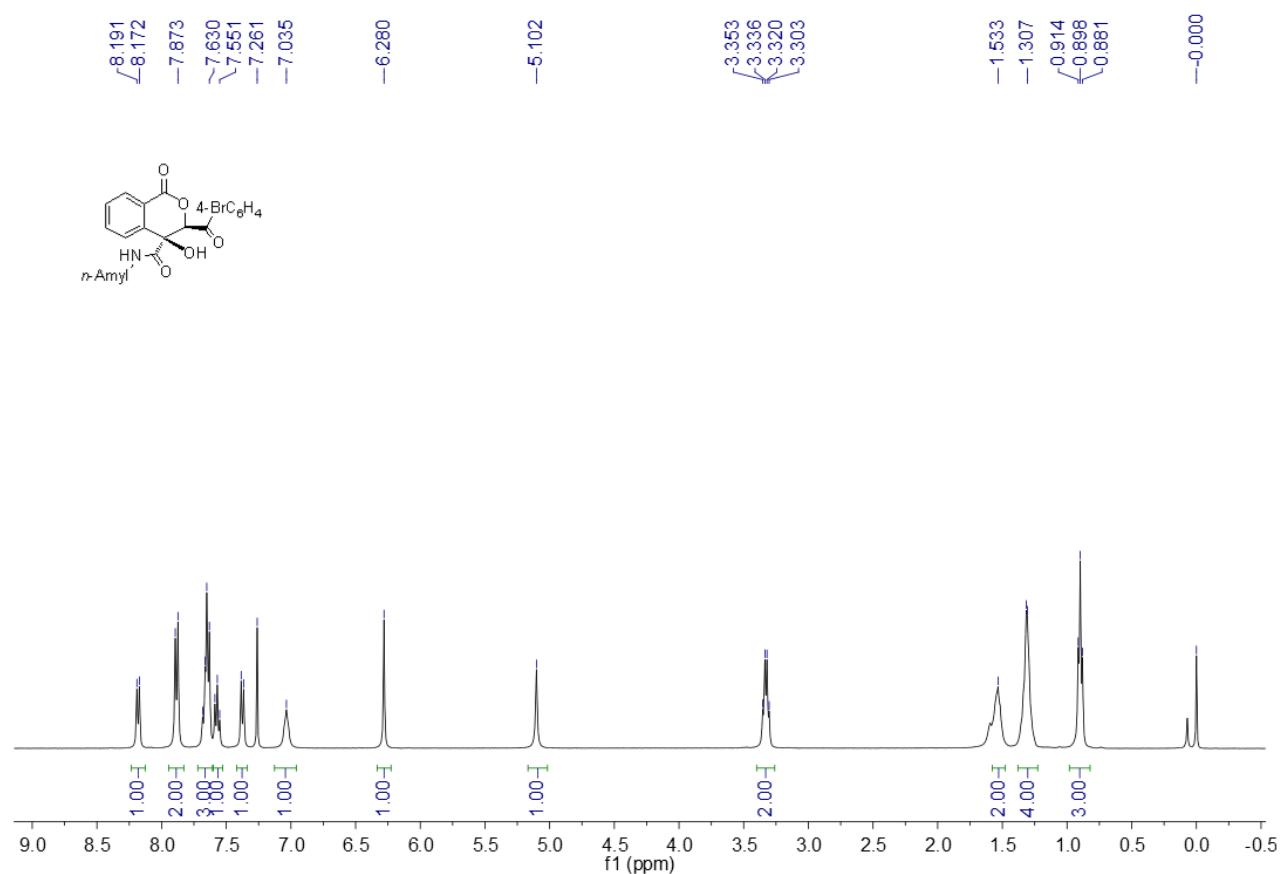


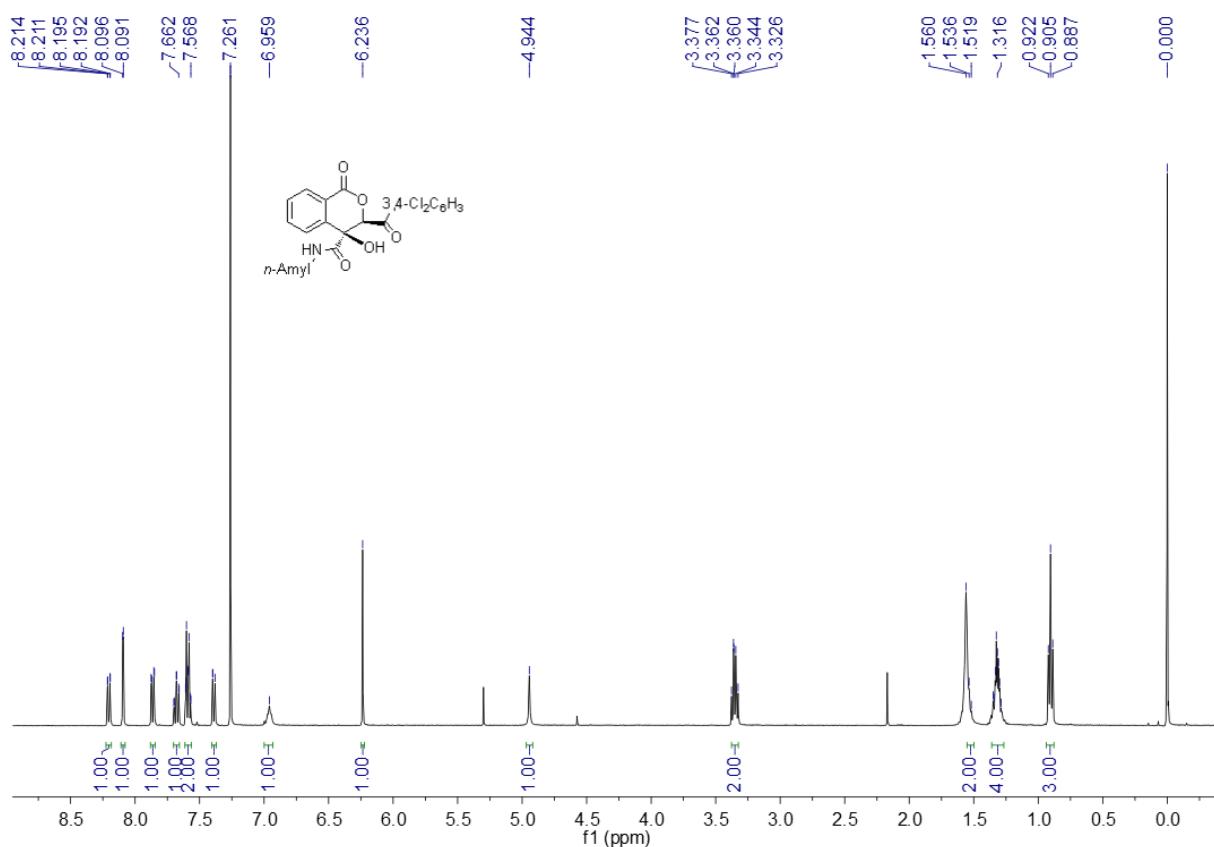
**<sup>1</sup>H NMR Spectrum of Compound 5d**



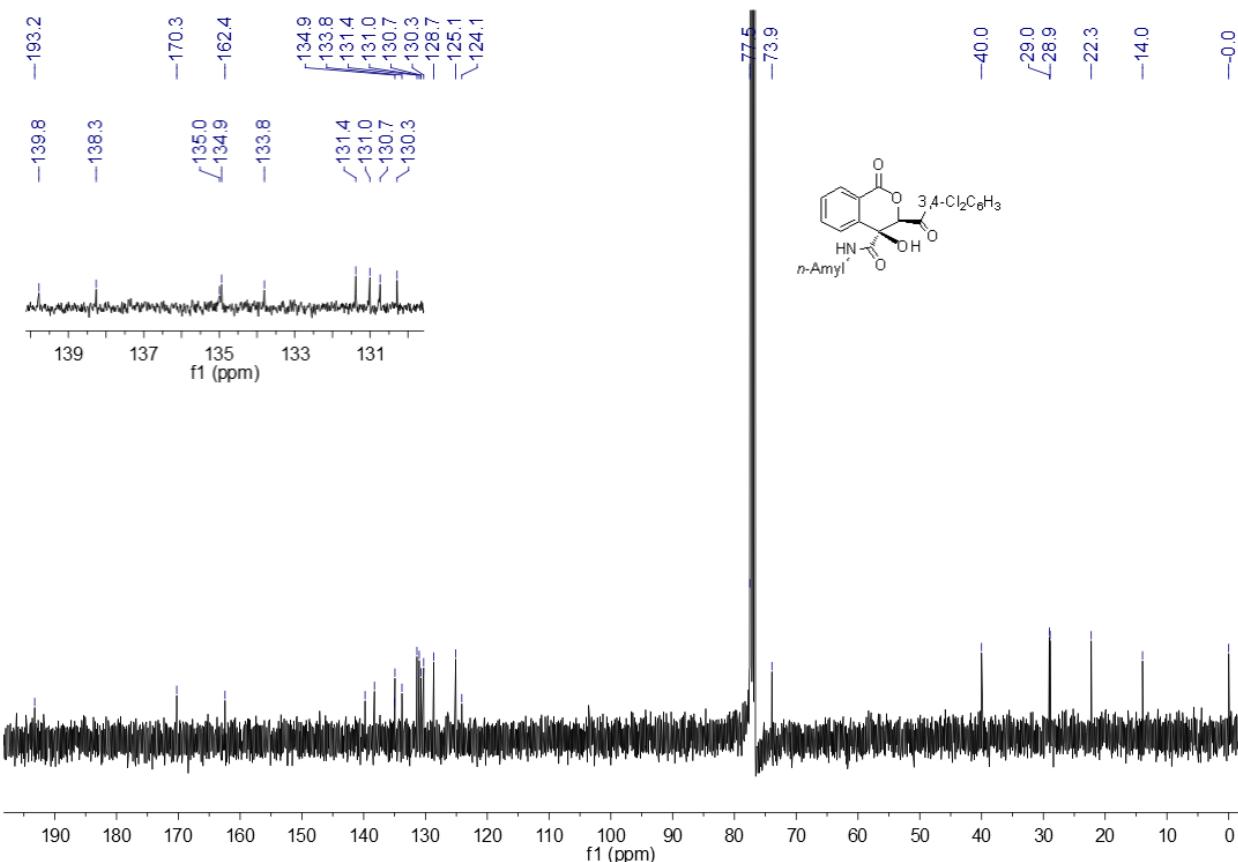
**<sup>13</sup>C NMR Spectrum of Compound 5d**



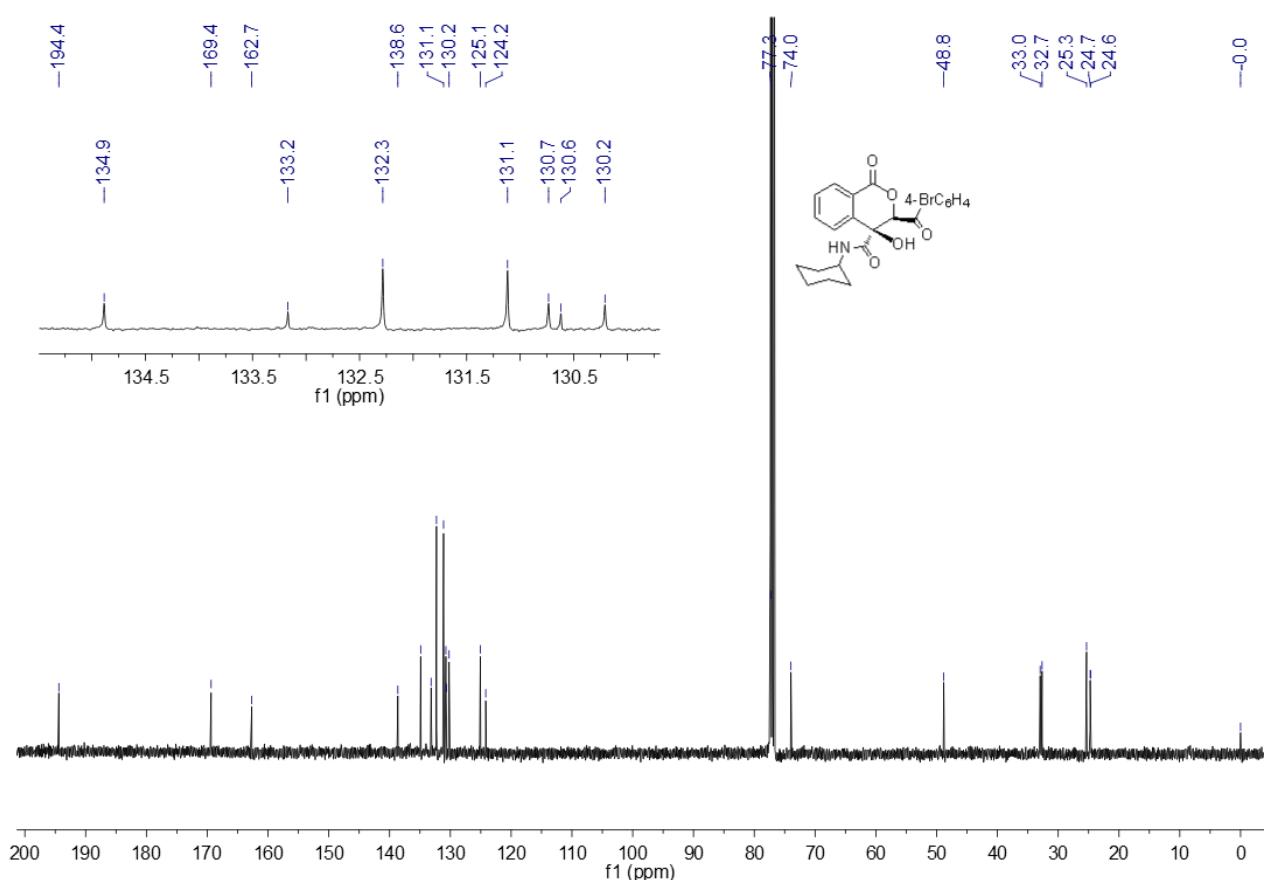
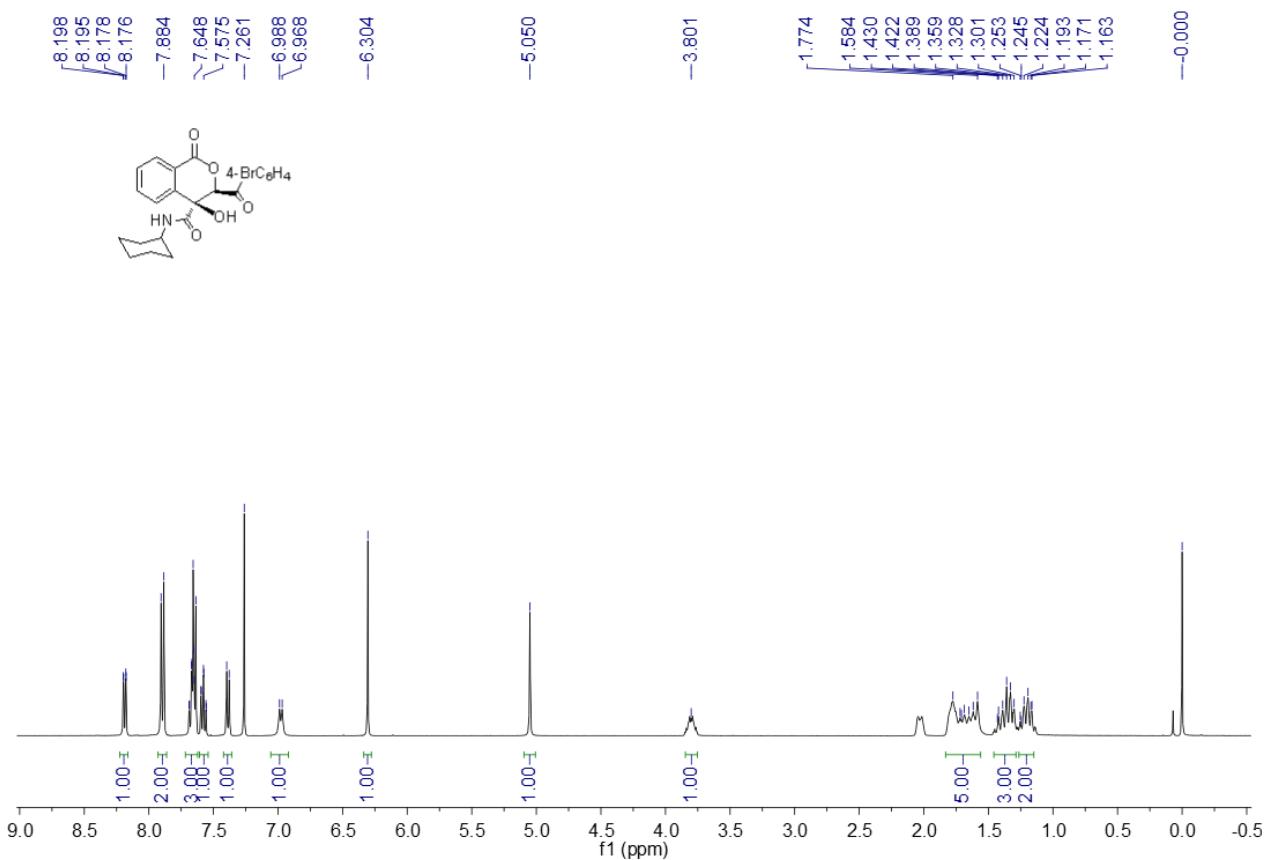


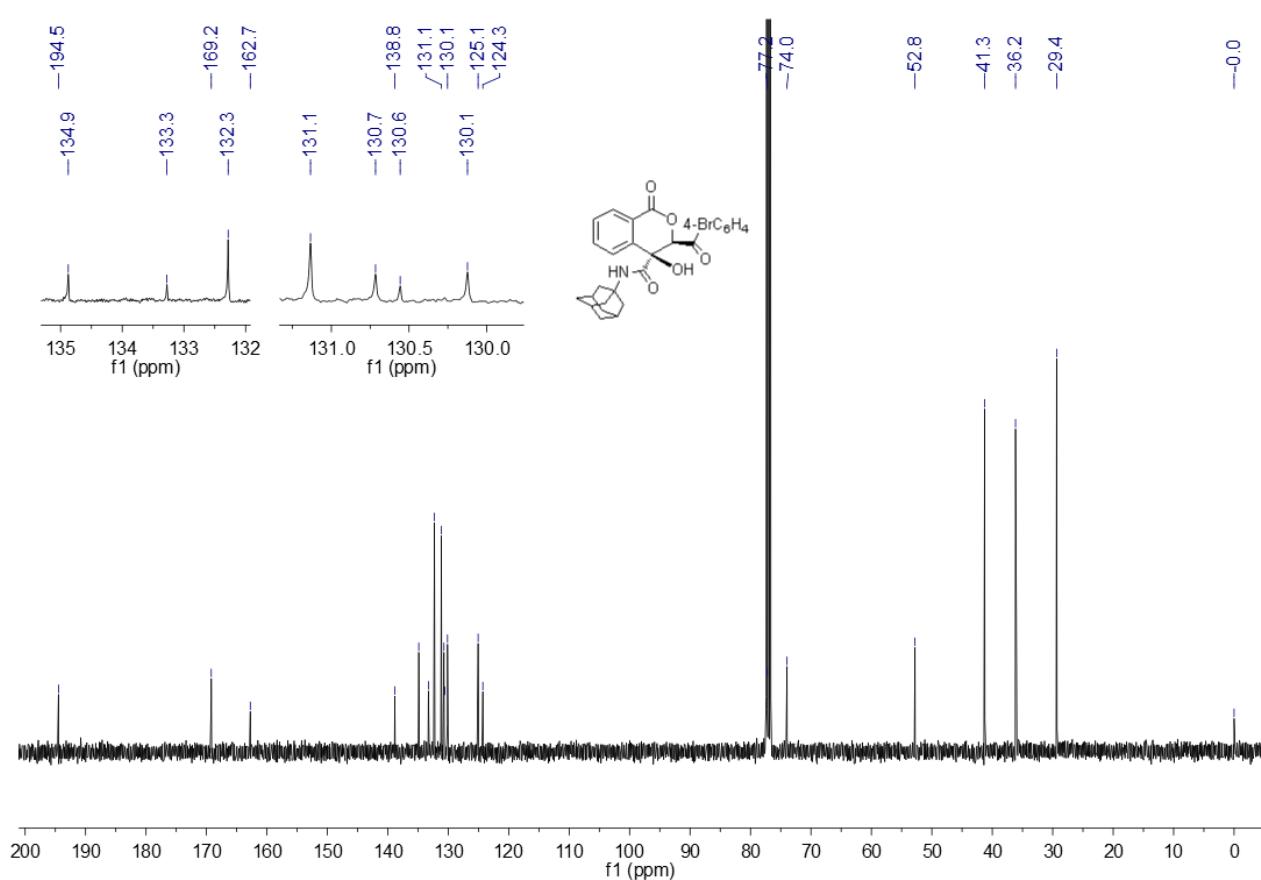
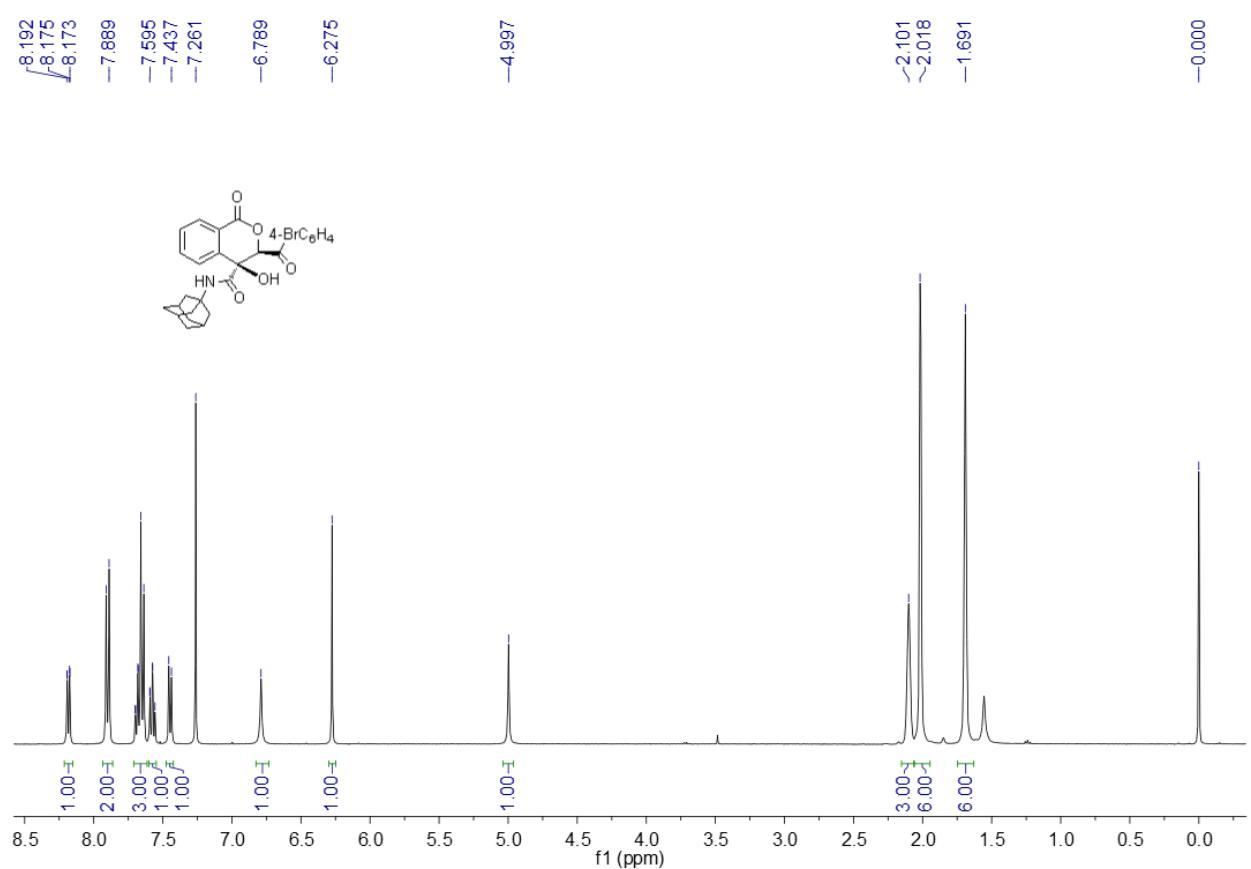


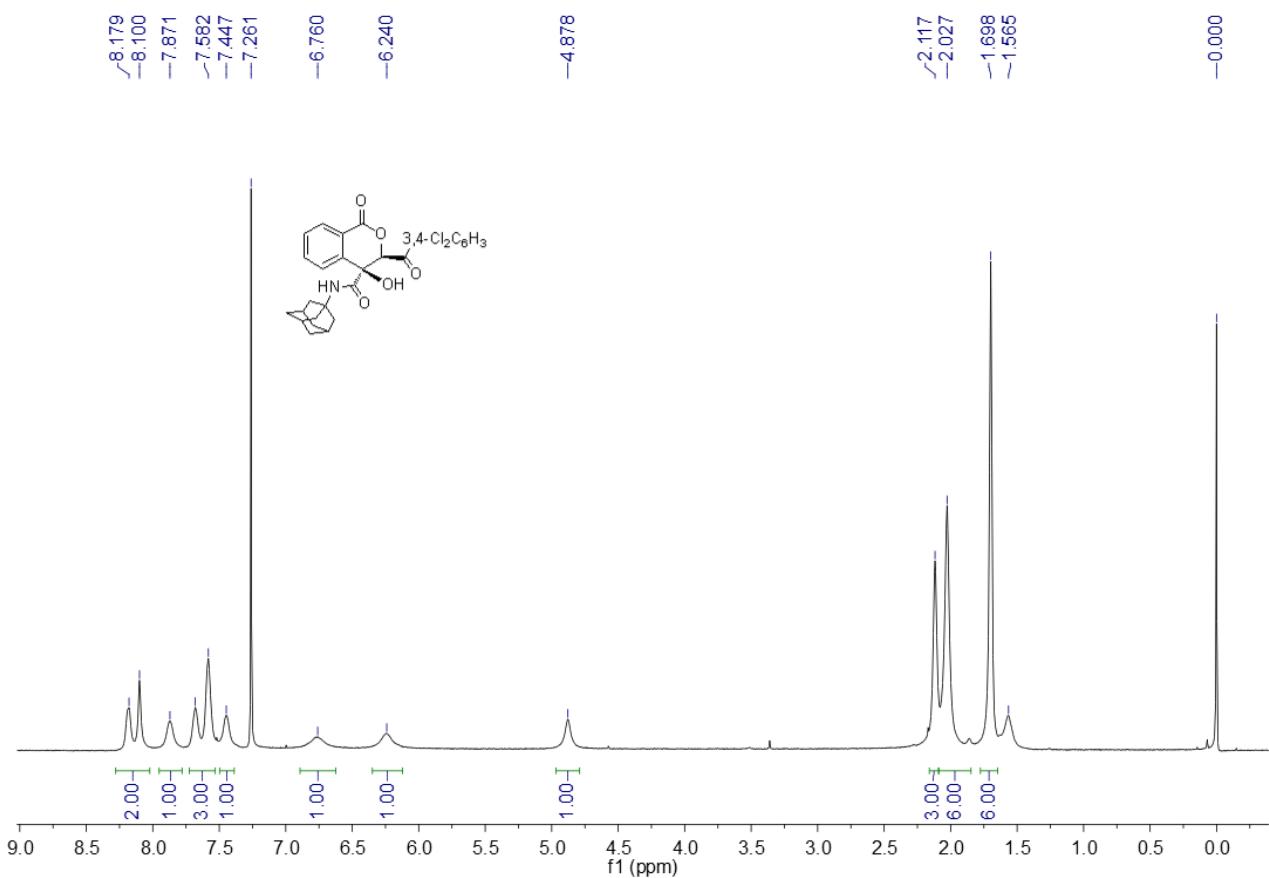
<sup>1</sup>H NMR Spectrum of Compound 5g



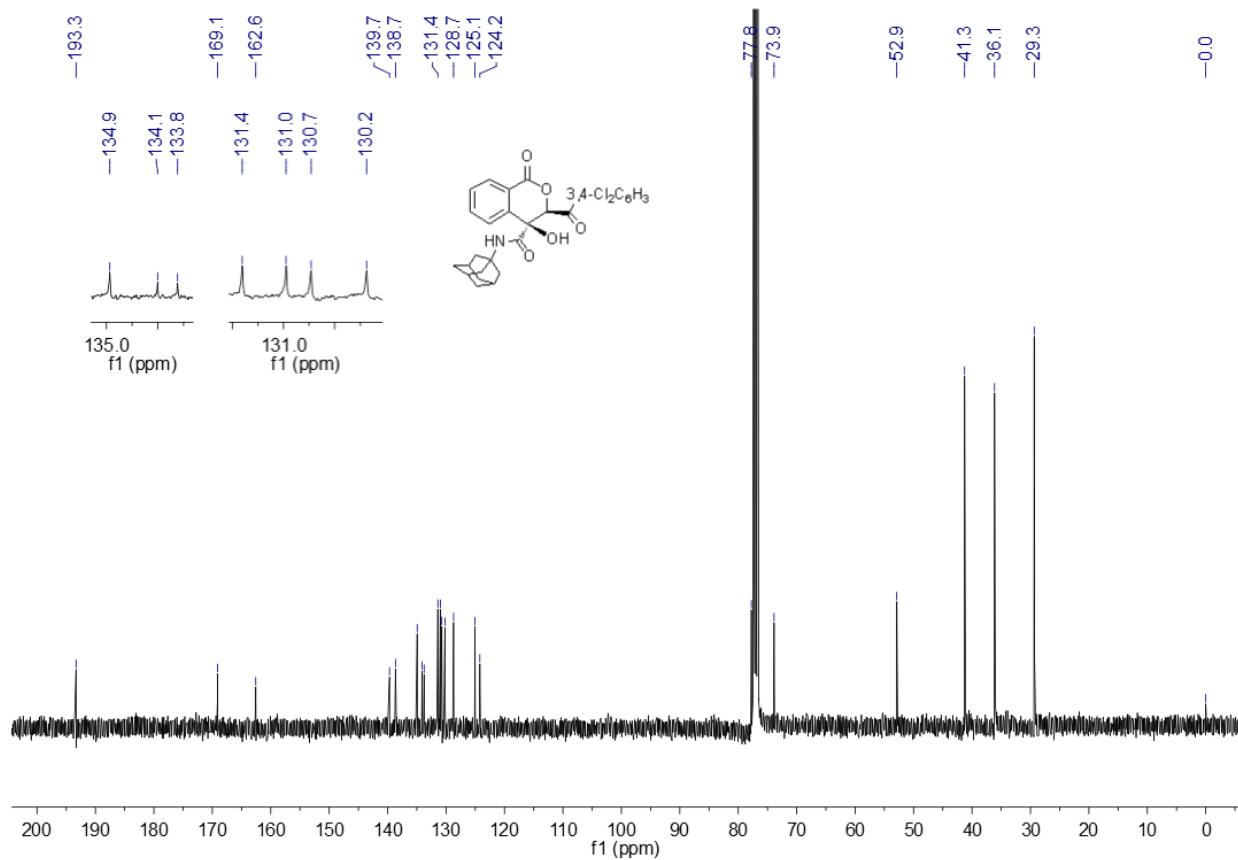
<sup>13</sup>C NMR Spectrum of Compound 5g







<sup>1</sup>H NMR Spectrum of Compound 5j



<sup>13</sup>C NMR Spectrum of Compound 5j

